August, 1949

EDISON ELECTRIC INSTITUTE BULLETIN

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	Page
Community Relations for the Electric Industry CHARLES E. WILSON	289
Operation of Synchronous Machines For Continuity of Service on the Southern California Edison Company System LLOYD F. HUNT and J. H. VIVIAN	293
Training Programs Designed to Meet Nine Objectives A. H. NIELSEN	301
Foot Rules For System Planning . . . . . R. G. HOOKE	304
The Electric Utility Industry Is Meeting the Country's Growing Demands . . . . . H. S. BENNION	309
Progress Report on Heat Pump Research	313
Personals	318
Conventions and Meetings	320

PUBLISHED MONTHLY BY EDISON ELECTRIC INSTITUTE

ELECTRICAL RESEARCH STATISTICS
THE ELECTRIC LIGHT AND POWER INDUSTRY

Current Statistical Data Covering 100 Per Cent of Industry

May, 1948-1949

SOURCE AND DISPOSAL OF ENERGY—MONTH OF MAY

	1949	1948	%
GENERATION* (Net)			
By Fuel Burning Plants	15,290,497,000	14,925,115,000	+ 2.4
By Water Power Plants	8,057,727,000	7,683,656,000	+ 4.9
Total Generation	**23,348,224,000**	**22,608,771,000**	**+ 3.3**
Add—Net Imports Over International Boundaries	129,600,000	124,300,000	+ 4.3
Less—Company Use	117,510,000	113,032,000	+ 4.0
Less—Energy Used by Producer	347,955,000	514,424,000	−32.4
Net Energy for Distribution	**23,012,359,000**	**22,105,615,000**	**+ 4.1**
Losses and Unaccounted for	3,098,141,000	2,942,883,000	+ 5.3
Sales to Ultimate Customers	**19,914,218,000**	**19,162,732,000**	**+ 3.9**

CLASSIFICATION OF SALES

NUMBER OF CUSTOMERS—As of May 31st			
Residential or Domestic	34,280,197	32,341,967	+ 6.0
Rural (Distinct Rural Rates)	1,721,962	1,596,259	+ 7.9
Commercial or Industrial:			
Small Light and Power	5,187,076	5,038,331	+ 3.0
Large Light and Power	228,836	195,578	+17.0
Other Customers	143,422	137,684	+ 4.2
Total Ultimate Customers	**41,561,493**	**39,309,819**	**+ 5.7**
KILOWATTHOUR SALES—During Month of May			
Residential or Domestic	4,464,261,000	3,912,960,000	+14.1
Rural (Distinct Rural Rates)	627,327,000	452,297,000	+38.7
Commercial or Industrial:			
Small Light and Power	3,610,657,000	3,382,397,000	+ 6.7
Large Light and Power	9,967,208,000	10,134,090,000	− 1.6
Street and Highway Lighting	190,118,000	175,588,000	+ 8.3
Other Public Authorities	509,665,000	503,526,000	+ 1.2
Railways and Railroads:			
Street and Interurban Railways	296,364,000	326,722,000	− 9.3
Electrified Steam Railroads	202,389,000	220,020,000	− 8.0
Interdepartmental	46,229,000	55,132,000	−16.1
Total to Ultimate Customers	**19,914,218,000**	**19,162,732,000**	**+ 3.9**
Revenue from Ultimate Customers	**$368,577,900**	**$341,931,600**	**+ 7.8**

RESIDENTIAL OR DOMESTIC SERVICE

AVERAGE CUSTOMER DATA—For 12 months ended May 31st			
Kilowatthours per Customer	1,616	1,498	+ 7.9
Average Annual Bill	$48.16	$45.55	+ 5.7
Revenue per Kilowatthour	2.98¢	3.04¢	− 2.0

(*) By Courtesy of the Federal Power Commission.

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EDISON ELECTRIC INSTITUTE BULLETIN

Volume 17 AUGUST, 1949 No. 8

Community Relations for the Electric Industry

By Charles E. Wilson
President, General Electric Company

Some remarks made at the presentation of the Charles A. Coffin Award for 1948 to the Union Electric Company of Missouri before the Chamber of Commerce, St. Louis, Mo., June 22, 1949

MOST OF us have at least two reasons behind our overt actions—an official reason and a real, personal reason. I am here, at your gracious invitation, to make an award, and there is nothing artificial about that. It is an award for achievement, an old American custom in which we can all glory.

With my official reasons duly stated, I should like to declare myself very briefly on another ground. When such a company as this is brought together, it presents one more golden opportunity to sound a call to arms in a cause which must forever be our first cause—the aggressive maintenance of the American way of business life.

Turn Back the Enemy

I believe sincerely that this cause stands today in danger and that every one of us must mobilize and activate his personal forces of economic strength to turn back the enemy. We may not succeed. We are in a constant state of flux, and it is entirely possible that in our time we may see the nationalization of industry and the complete socialization of American life. If that happens, historians will have every right to say that justice apparently triumphed and that the enterprise system, having exhausted itself in the struggle for survival, was finally retired in favor of something better tuned to the needs and desires of the people of the United States.

If that happens, we will have no cause to complain. Like the Confederacy, we can then look forward to a long period of literary glory and romantic speculation. People will write books about us and our exploits. We will no doubt continue to live on in the movies—movies produced by the state with public funds.

If nationalization of industry—electric power, steel, oil, or anything else—happens to us, as it has happened to England, for example, it will be our own fault. We cannot fight it with words alone, but we can fight it with actions. This is a broad front, like any front, and although a few feet of it such as you or I can usually see across our desks does not seem to amount to much, yet every foot of it is vital to our continued existence. Break-throughs are fatal.

There is just one thing about such a prospect that puzzles me in passing. Socialized economies appear to stay alive principally by virtue of transfusions from healthy, capitalistic bodies, and after we are gone, I don't know where the transfusions are coming from. The world will have run out of convenient blood-banks, and it will be interesting to see what happens next.

In spite of what may sound like sardonic attacks upon something, in spite of all of this talk about mobilizing against an enemy, please don't believe that I am attacking any particular person, or group, or government body, because I am not. This is more of an admonition to ourselves to straighten up and fly right. Just as the human body carries within it the seeds of its own

Union Electric Receives Community Testimonial As Coffin Award Winner

THE luncheon at which Mr. Wilson made the accompanying talk had a purpose beyond that of reenacting the presentation of the Charles A. Coffin Award, originally made at the EEI Convention at Atlantic City in June. It was a testimonial to Union Electric given the company by the community it serves. The luncheon was sponsored by the St. Louis Chamber of Commerce and nearly 600 people filled the ballroom of the Statler Hotel almost to overflowing.

On exhibit outside the ballroom, and creating great interest among the civic leaders attending the luncheon, was a display of the Coffin Award Medal and Union Electric's prize-winning entry. The company plans to feature the display in all of the twenty-five company stores throughout the Union Electric System.

The company is sponsoring a contest among its employees for the best suggestion as to how the $1000 check, accompanying the annual Coffin Award and ear-marked for employees' benefit funds, can be most usefully spent. A prize of $100 will be given for the best suggestion.

Extensive stories on the Coffin Award were carried in the employee magazines, Union Electric News and Union Electric Quarterly, as well as in newspapers published in the Union Electric service area.

destruction and the agents to overcome and control such disease, so does our economy have within its lifestream conflicting forces. It is those forces, for evil or good, to which we must address ourselves.

The official reason for this appearance, as has been observed, is the conferring of an award upon the Union Electric Company of Missouri. I have always felt that the true significance of a medal, or a citation, is often lost because our attention is concentrated upon the recipient. There are two important phases, or characteristics, about any award if it is not to be just a dead thing. First of all, it looks not to the past but to the future. Definitely it faces forward and demands that what lies ahead shall be met with the same talent and courage, the same skill and judgment and vigor, as was thrown into action yesterday. If anything, an award makes life infinitely tougher for the fellow who gets it, because he must wear it with responsibility before his fellow citizens.

The other characteristic is that any award of merit—if it is to confer distinction—must also honor the giver. If Caesar is dissolute, or weak, or a tyrant, or if his favors can be purchased, who wants his medal?

There is much deserving of honor in the great adventure of American industry. It is fair to say that we have all been a little backward in recognizing it publicly. We have been too busy making things and selling things and building plants and creating jobs and markets to pin many medals on the chest of business—and I mean that in a figurative way, of course.

The right way to honor the enterprise system is to explain it. Occasions such as this are only one kind of opportunity. The important thing about an award to a utility company such as Union Electric is not an inscribed piece of paper, a medal, or a check, but the satisfaction of customers and the service and performance that lie behind that satisfaction.

A Good Company in A Good Community

To the men and women of your community you do not say: "Behold this certificate!"—but you *do* say: "This is a *good* company, in a *good* community, in a great country. But we have become good only at your pleasure, because we serve you with an important product at a fair price. We do so honestly and to the best of our ability—and our ability is increasing. We recognize our obligation to you, and we aim to earn your confidence and your friendship. Our methods, our plans, and our business morals are an open book, and we invite you to turn the pages, because this is a chapter in the story of progress. This is what makes your country strong."

I sincerely hope that this is the way in which you of Union Electric receive your award, because it will honor you and it will honor private business, from which it comes.

Actually there is not the least doubt in my mind that any other course will be followed. I don't know how many people here are familiar with the specific reasons for which this award was granted by the committee of the Edison Electric Institute — this organization was cited for a remarkably broad and successful community relations program begun some ten years ago. Before coming out to St. Louis I was examining an outline of the various activities and objectives which comprise this program, and I was struck by two or three things.

A New Magic

First, that such a program should have been in progress for a decade is a little unusual. Those of you who are associated with the practice and the terminology of public relations know that we did not hear much about community relations until a relatively few years ago. Then almost overnight it came to be an accepted and popular expression with a fairly definite meaning. Everybody took it up and discussed it at conventions, and in their zeal I believe that some of them thought they had hold of something new, some kind of magic that came in a box and could be purchased and applied to any community where things were not going too well.

Actually there is nothing new about the institution and the development of a community relations program. A long time ago it was peddled by a number of humble and distinguished individuals under the name of the Golden Rule—not very effectively, I am afraid. A better merchandising job might have been done. Nevertheless what we have today is this same old-fashioned remedy for friction and hostility and distrust between man and men. There is no change in the ingredients. The change is in the minds of men, like ourselves, and perhaps that is the most important change of all.

American business and industry, in its vigorous growth years when it was coming up to speed and charting the path of its future progress, did not have too much time for applying the Golden Rule, because it did not have too much time to consider the individual. There were devices to be invented, better machines to be built. There were great physical areas to be explored and colonized in terms of manufacturing and selling.

Eyes On the Horizon

There was so little time for the innumerable things that had to be accomplished, and the men of industry were always a little out of breath with striving and anticipation. They had their eyes on the horizon, not on the man next to them. Particularly was this true of the electrical industry, which in its various manifestations has so completely changed the face of the earth and the lot of those who live and work on it, all in a very short time as such things go.

There is nothing in this story of our industrial past to be ashamed of, or apologized for, no matter what the critics of business may say today. We were growing up in a new land, and first things came first. No youth grows to manhood without indiscretions and mistakes and a certain number of cruelties to his fellow men, and American business was no different. As a total force its achievement has been great.

Now it has come to maturity, and both its problems and its opportunities have increased. The sociological implications of that maturity, and the economic implications of that maturity, have emerged, and in the last twenty years we have come face to face with them. A bitter depression and two great wars have forced all of us to consider the problems of private business in terms of their human relations—relations which always existed, but which received a minimum amount of study and attention.

Business Self-Analysis

Community relations, like relations with employees and stockholders and customers, are therefore not something new. They are something to which we are now consciously putting our hand and our brain to the end that we may improve them. They represent first

stock-taking, or period of rigorous self-analysis, on the part of business, followed by an equally conscious and conscientious effort to cut through the extraneous matter and get to the heart of the problem of how best to live together honestly, fairly, and profitably.

We are today honoring an organization, therefore, which preceded many of its fellow companies in undertaking such a job. The first thing about such an effort—as in the case of applying the Golden Rule itself—is that it immediately benefits not only the practitioner but all who come within its circle and touch hands with it.

A Group of Human Beings

Another thing that struck me about this program, when examined in detail, was the number of details and smaller programs which it encompassed, all of which add up simply and surprisingly as the application of old-fashioned common sense. You will find such elements as the provision of reasonable rates and reliable service, emphasis upon the fact that a company is after all a group of human beings and not a bloodless corporate structure; recognition of the fact that management has a responsibility to operate efficiently and economically and that it must be solidly financed; that there must be a fair return to those who invest their money and their time; that no company has any existence except in the physical form which it takes in any given community; and that the public is entitled to full and frank information about company operations.

There are many other elements, but if there is one above all others which may be said to be new, it is this element of taking the neighbors of a community into your confidence. Business did not always operate that way, as you know. Much of it lamentably gives only lip service to that concept today, and some of it still does not recognize it at all.

Charles A. Coffin

With your permission, I would like to say a few words about the man whose name has been given to this award—Charles A. Coffin, the founder and first president of the General Electric Company.

Our company, and our industry, is probably first and best known for another kind of individual—the scientist and the engineer. Edison, Steinmetz, Westinghouse, Sprague, Stanley, Thomson and a host of other giants wrote the romance and triumph of the electrical age in splendid and familiar terms, and for that they have been recognized and honored.

Their descendants today are blazing new scientific trails in laboratories across the land. But. Mr. Coffin was another kind of man, with another kind of genius and courage. Throughout his lifetime he shunned the spotlight, preferring that it play upon the men of engineering and research who were in the center of the stage. Coffin was a financial pioneer and organizer, a man who fought the less glamorous battles of risk capital and commercial credit and factories and machines. He left a secure and prosperous business in order to launch a new industry in which he had great faith and high expectations.

He not only had to see that the new products of the electrical industry were manufactured but had to go out and create markets and customers for them, almost against their will, and then he had to find some way of financing the customers themselves during the lean years so that they could buy. He had to reconcile conflicting patent claims so that the industry could grow and not bleed itself to death. He had to convince skeptical men of substance to come along with him and share the risks and disappointments of this new venture.

Man of Vision

He had to face one of the greatest panics of all times with desperate measures invented on the spot. He had the bold vision to foresee and count upon such things as great utility systems, electric transportation systems, and industrial electrification projects, all of which seem commonplace to us today, but which then were ridiculed as crazy and impracticable dreams.

He was a man of business in the finest sense. I somehow think that he would have taken a particular satisfaction in seeing an award bearing his name presented for the kind of effort which we are today recognizing here.

My special purpose in sketching this brief picture of Mr. Coffin, aside from explaining how the award itself came to be thus named, is to develop a thought begun earlier, and pose for your consideration what I believe to be the main issue before us today.

We have been in agreement, I believe, that in this mature period of industrial development the problems of private competitive enterprise have come to be stated more and more in their human terms. This has been, of course, very evident in the post-war economy, where stress has been upon such things as wages and prices, two very human considerations.

Wages and salaries are what men earn for the investment of their time and talent. Traditionally in America the amount of those wages has been determined by the skill and output of the worker, and the level of those prices has been determined by the cost of materials and labor plus the desire and ability of the buyer to buy the commodity or product in question. To put it somewhat more simply, it has been our established custom that a man was paid what he earned by his work, and that he bought what he could afford. This was the democratic marketplace, for services and for products.

Vested "Rights"

Today we have come to the point more and more where artificial factors invade the area of wages and prices—we hear of such things as the right to a job, the right to a certain level of income; the right to a certain market price for a commodity even if it has to be supported by subsidy; the right to pensions and hospitalization and unemployment insurance; the right to enjoy a certain standard of living. Not for a moment would any intelligent man deny the gradual conquest of the inequities of life.

We all want better working and living standards, better national health, and more security. But we must realistically face the fact that the "rights" to all of these things can vest in only one way, by government provision out of the public treasury, and after due legislation. Such vested rights cost money, more money than we can perhaps afford as a nation.

I believe that it is entirely possible to progress to continually higher standards of living through voluntary efforts without having such progress guaranteed by government. Actually the government can make no such guarantees, anyway. It can validate such "guarantees" only up to the point that it can pay for them out of tax money; and it can pay for them out of taxes only up to the point where a reasonable and equitable tax structure allows the individual or corporate taxpayer to continue to live; and when we arrive at a point where a politically-encouraged wage structure

and a politically-inspired tax structure hamstring the real producers of our national wealth, then we will all go broke and the disciples of planned security and the welfare state will have reached the logical but tragic completion of their program.

It is the great responsibility of American business to see that this does not happen. There is a great deal of room in which to operate intelligently between the two extremes of blind reaction and socialism, and the key is voluntary action by private industry. Economic morality is seldom found in government circles simply because there is no pressure for it.

The Uneconomic State

The pressure to make income and outgo match, to live within a budget, to establish reserves, to deflate extravagance, and to produce efficiently, is entirely lacking when government is the employer. The pressure is most often political, and it pushes in the opposite direction. It was most harshly and realistically described by the Governor of the State of New York in 1932—a man who later became President, as you will recall—when he said:

> "Were it possible to find master minds so unselfish, so willing to decide unhesitatingly against their own personal interests or private prejudices, men almost God-like in their ability to hold the scales of justice with an even hand—such a government might be to the interest of the country; but there are none such on our political horizon, and we cannot expect a complete reversal of all the teachings of history."

It was voluntary action by private business, seeking continually to improve its products, its services, its prices, its values as an investment, its stability as an employer, and its dependability as a citizen, which was so exceptionally symbolized by Charles A. Coffin, even though he was operating in an era, as we have noted, that was notable for growth rather than maturity. I think the moral adds up to this, just as in football, that the best defense is a good offense.

Private industry generates its own momentum, and that momentum can be so considerable in the public interest if we keep the public interest foremost in our thinking that there will be little room for attack by the malcontents and economic changelings, or by the politicians, either.

Angus McLay

ANGUS D. McLay, vice president, sales department, of The Detroit Edison Company, died at his home in Birmingham, Michigan, on July 20. He was born in 1887 in Canada and attended the public schools of Sault Sainte Marie, Michigan, and the University of Michigan. In his various positions with Detroit Edison, Mr. McLay played an important part in the early development of electrical refrigeration and air conditioning, electric cooking and water heating and improvements in fractional horsepower motors.

Mr. McLay started to work in 1906 as an operating engineer with the Michigan Northern Power Company, Sault Sainte Marie. In 1914, while studying electrical engineering at the University of Michigan, Mr. McLay was hired by Detroit Edison as superintendent of the former Eastern Michigan Edison Company in Ypsilanti. He was later transferred to the Detroit office and worked up through the ranks from a clerk to a vice presidency. Mr. McLay was appointed senior sales engineer in 1929, assistant sales manager in 1935, sales manager in 1938, and was elected a vice president in 1943.

In 1917, Mr. McLay volunteered for military service and served overseas, rising to the rank of a major in the United States Army Signal Corps.

Mr. McLay was a past president of the Michigan Electric Light Association and the Utility Sales Executives Conference of the Association of Edison Illuminating Companies. He was also active in the Detroit Community Fund and the Detroit League for the Handicapped.

A few of you who happened to be in the audience at the Edison Electric Institute meeting in Atlantic City earlier this month were kind enough to suggest that it might be worthwhile for me to repeat some of the things I said there. I haven't done that to any great extent, since that was a meeting of electric utility people and your interests are somewhat less specific, but because we are here today to pay recognition and tribute to one of the country's outstanding public utility companies, perhaps I can point up my concluding remarks by borrowing just a little from that talk.

It seemed to me that one of the gravest situations, and at the same time one of the brightest opportunities, in this whole business of keeping America pointed right economically, faces the electric light and power industry. This is a key business in the mighty economy of the country. It has been built on pioneering, on individual ingenuity, on courageous private financing, on aggressive selling, on fundamental relationships with the public, so well exemplified by Union Electric's program.

In its relatively short life, the utility business has been mistaken, shortsighted, humanly selfish, and honestly perplexed as it worked out the intricate new ground of government regulation flowing from the nature of the commodity, electricity. But along with, and in spite of, all these things, it has fantastically and almost unbelievably transformed the lives and influenced the fortunes of every individual, every home, every farm, every store, and every factory in America. The miracle of electric power—one of the truly great miracles of modern life—is not scientific achievement, however, but economic achievement, on a scale so vast that we have never been able to evaluate it truly, and we just take it for granted.

These are some of the things we have in mind today in the electrical industry when we speak of competitive private enterprise, when we make promises in the name of private business, and nowhere are they better exemplified than in this industry which is frankly under attack. We cannot meet this attack, I am convinced, with resentment and righteous hostility, but we can meet it with action.

We think this is a good place to stand and fight, by making sure that the electric power industry is ready to expand, finance, and develop new electric generating capacity where it is needed and wanted. We think this is our business, not government business, and it coincides with the tradition of our industry, which is a tradition of action.

Fortunately you here have seen an example of that kind of action, and you will see more of it. This is an award, I repeat, which looks in two directions. It has been my privilege to help honor today a company in which you can take neighborly pride, and I know you will join with me in being proud also that we can recognize in this tribute our own individual contributions as co-trustees of America's economic strength.

Operation of Synchronous Machines for Continuity of Service on the Southern California Edison Company System

Part I—Over-Voltage Testing

By Lloyd F. Hunt
Chief Electrical Engineer,
and
J. H. Vivian
Chief Engineer, Division of Apparatus and Protection,
Southern California Edison Company

A paper presented before the Electrical Equipment Committee Meeting, EEI, Chicago, Ill., May 3, 1949

SINCE 1942, the Southern California Edison Company has studied the problem of determining the condition of large synchronous machine windings and has accumulated experience in the operation of these machines with their neutrals ungrounded.

The purpose of this paper is to summarize the results of field tests and operating experience from which present procedures have been developed. The paper is comprised of two parts, Part I describes the development of an over-voltage test procedure, and Part II relates the history of conversion from the solid grounding of machine neutrals to the present practice of grounding through a potential transformer with ground detecting devices. Part II is scheduled to appear in a later issue of the BULLETIN.

Continuity of Service

The operation of all power system equipment for continuity of service is of vital interest to every electric utility company. The Southern California Edison Company has studied this problem, and has accumulated practical field experience in the operation, testing, and maintenance of large synchronous machines during the last six years that should prove valuable to electric machinery manufacturers and other electric utility companies. This paper is a review of the development, practice, and results of a program of over-voltage testing of large synchronous machines, and the experiences of this Company with respect to grounded and ungrounded neutral operation of large synchronous generators and condensers.

The electric power system of the Southern California Edison Company serves the ten central and southern counties of California. There are approximately 900,000 customers in this 18,500 square mile area. To reach these customers requires over 16,000 miles of line, 214 distribution substations and thirty-five high-voltage transmission stations.

System Capacity

There are fifty-nine hydroelectric generators in twenty-four plants, with a total capacity of 1,003,650 kva, or 936,000 kw. There are thirteen steam electric generators in four plants with a total capacity of 604,981 kva or 521,500 kw, and five diesel electric generators in one plant with a total capacity of 37,500 kva or 30,000 kw. In addition to this generating equipment, there are thirty-two synchronous condensers in twenty stations with a total capacity of 1,061,500 kva, and one frequency changer of 60,000-kva capacity. All together there are 110 machine windings with a total capacity of 2,767,631 kva to be maintained.

The normal operation of a power system of this extent is extremely complicated, and unpredicted failures can seriously affect the operating plan. Power sources are widely separated in space and involve expedient use of hydro, steam and interconnections with other systems. Predetermined allocation of loads to source is necessary for conservation of fuel and water.

Interconnection with other power systems such as the City of Los Angeles, the Pacific Gas and Electric Company, the San Diego Gas and Electric Company and others requires the long-range coordination of outages for routine maintenance. Overhaul periods for hydroelectric equipment are scheduled when the run-off is low, and steam electric generator overhauls are scheduled for a time of year when water supply is maximum. Unanticipated outages of either class of generation may be costly not only to the Southern California Edison Company, but may also affect the plans of interconnected companies.

Higher Load Factor

The recent rapid growth of this area has increased the demand for power to an amount that requires operation of all generating facilities at higher load factors than ever before. The importance of all customers' loads and especially those of major industrial plants, and continuous process plants such as paper mills, rubber mills, steel mills and glass plants makes it imperative that failures of large units while in service shall not occur.

It is also important to know the condition of these machines so as to be able to reduce the system spinning reserve to a minimum. If it could be assured that no machines would fail in service, the number of machines in reserve could be reduced without reducing the reliability of service to the customers. It would be of further advantage when scheduling planned outages to be

sure that the remaining machines will continue in operation.

The Southern California Edison Company has for many years followed a rigid schedule of inspection and maintenance on all major equipment. All important hydro and steam units are annually disassembled as required for thorough inspection and tests.

Details of Winding Inspection

Some of the important items examined for the stator and rotor windings are as follows:

Stator Windings:

1. Check for loose wedges.
2. Check for broken, damaged or missing wedges.
3. Check end wedges for movement at the end of the core and all other wedges for position.
4. Check coil ends for distortion.
5. Check security of all lashings and spacers.
6. Check tightness of coil support brackets.
7. Check for loose coils in slots.
8. Check coil ends for cracks in the insulation or for mechanical damage.
9. Check all connections between coil and connections around frame.
10. Measure insulation resistance of winding to ground from the machine terminals.
11. Clean thoroughly where required.
12. Protect finish by revarnishing as needed.

Rotor Windings:

1. Check clearance between blowers and coils.
2. Check for movement or shifting of field coils.
3. Check the dirt on winding and take necessary cleaning steps.
4. Inspect strap field coils for condition of turn-to-turn insulation.
5. Check condition of ground insulation and washers or collars.
6. Check connections between coils and to the collector.
7. Check all bolts for any looseness.
8. Measure insulation resistance to ground of field windings, including the collector and apply 500 volts a-c from winding to ground.
9. Check for shorted turns.
10. Refinish with varnish as required.

Records of the conditions found during these inspections are kept for all machines in order that signs of developing troubles will be brought to attention and corrected, or an estimate made of the safety of continuing to operate.

In spite of the careful visual inspections, measurement of winding resistance, and maintenance program described, some failures in service have occurred.

After having overhauled a unit and given it the rigid inspection outlined, it is very disconcerting to have a winding fail between overhaul periods. However, if actual insulation failure is to occur, this can only happen when the unit is energized, unless it is given some test during the overhaul period that will show sufficient evidence of impending failure to justify immediate repair or rewinding.

The nature of insulation failures in machine windings makes it practically impossible to predetermine the exact time of failure of equipment in service. This condition has long been recognized in the industry, and a very great deal of thought and work has been done in an effort to discover some simple and reliable non-destructive test to apply that would measure and show the condition of the winding insulation.

EEI Committee Appointed

The Edison Electric Institute Electrical Equipment Committee undertook active work on this problem in 1935. In 1937, a Special Subject Committee was appointed on "Generator Insulation and Testing." This Committee directed the investigations of various member companies and others in the industry, and maintained close contact with the electric machinery manufacturers, with the ultimate objective of developing a reliable test procedure for determining the condition of winding insulation.

An interim report of the work of this Committee appeared in the December, 1941, *Transactions of the AIEE*. Some of the conclusions reached at that time are as follows:

1. Insulation resistance varies widely and is affected by so many indeterminate factors that a "spot" reading is of little value. However, periodic readings taken with consistent controlled procedure will indicate a trend of the general condition of the insulation.
2. The slopes of resistance-time curves are satisfactory indices of excessive moisture in the insulation.
3. Power-factor tests have given little indication of value in locating faults or incipient faults in machinery. However, like insulation resistances, periodic power-factor measurements may be an indicator of the trend of the general condition of the insulation.
4. Sixty-cycle ionization tests have given no indication of value in predicting insulation failure or for locating weak spots in windings.
5. The dielectric strengths of old windings have been found generally high.

The investigation by this Committee resulted in considerably better understanding of the problem, and furnished a useful guide for further work and standardization of insulation testing.

Work on this subject continued, and in December, 1946, the Sub-Committee on Insulation Resistance of the AIEE Committee on Electric Machinery, published a report on Recommended Practice of Insulation Resistance Testing of A-C Rotating Machinery.

This report reviews the factors that affect the insulation resistance characteristics, recommends uniform methods of making insulation resistance tests, and presents a method of determining the approximate minimum insulation resistance values for new rotating machines to aid in interpreting the results of insulation tests on old machines. However, no correlation between the measured condition of insulation and dielectric breakdown was given.

In spite of all that has been done, it appears that no really reliable non-destructive test is available for predicting the probable remaining life of rotating machine windings in service. No consistent relation between the insulation resistance and dielectric strength has ever been found.

Over-Voltage Testing Necessary

Local failure can occur in a winding which will appear good by any method of test that does not apply over-voltage to a winding. It therefore appears that if failure in service is to be avoided, it is necessary to use over-voltage testing.

Insulation deterioration as well as breakdown depends not only on the magnitude of the applied voltage, but also on the length of time of application. The time of voltage application to cause failure of weak or deteriorated insulation is less than for good insulation

Hence there should be a value of test voltage and length of application for periodic testing that will provide the desired degree of freedom from failure in service. It was with this idea that the engineers of the Southern California Edison Company initiated in 1942 a program of investigation and test in order to develop an over-voltage test procedure that would give the desired results.

Before establishing this procedure of over-voltage testing, or determining the voltage to be used, a review of the existing literature on this subject was made and various manufacturers were requested to furnish information concerning available methods of fixing the "Life Expectancy of Windings" by non-destructive tests which could be made at the time of overhaul, and to comment on the use of an annual 150 per cent over-potential test. The comments received in 1944 indicated that the manufacturers did not know of any non-destructive tests that would provide reliable information on the condition of winding insulation. Repeated high potential tests were not generally favored.

Many Variable Factors

Based on the comments received and our own studies, it was recognized that a reliable method of determining the actual remaining life of a winding was not available. The windings of the machines on the Edison System vary greatly in age and condition. Some have just been put in service, and some have been operated without rewinding for thirty-five years. Load and service conditions have varied greatly, so that age alone is of no practical value for determining serviceability.

Testing Program Adopted

However, it was considered necessary to take some action immediately to minimize the possibility of winding failures in operation and the following program was adopted:

From the case history of each winding, an analysis was made to determine which windings could not reasonably be depended upon to operate without breakdown. In this group were placed all machines whose record showed the windings to be in poor mechanical condition, or whose windings would not carry full load without excessive temperature. These windings were to be replaced on the next annual overhaul.

It was planned to make over-voltage repetitive tests on these old windings at the time of removal. The results of these tests were to be used to establish a satisfactory over-voltage test value to be applied to all machines during the annual overhauls. A proper voltage for such test should be high enough to cause failure during test if any spot in the winding was seriously deteriorated, but must be low enough not to cause additional deterioration because of its application.

These were made on the windings of a 28,000-kva, 11.0-kv generator which was to be rewound. Fig. 1 shows the arrangement of high-voltage test equipment. The tests were made after the rotor had been removed, but before the windings were stripped from the stator. The line and neutral leads were disconnected at the generator terminals.

Repeated over-voltage tests were made on each phase to the other two phases and ground. The test procedure consisted of building up the voltage from zero to 17,250 v for 50 successive tests of one minute each. The voltage was decreased to zero between each test and immediately built up again to the test voltage. For the first test in each group, the voltage was raised approximately 2 per cent above the nominal test voltage to preclude the chance of failure during the subsequent tests due to voltage fluctuations.

Test Results

The insulation resistance was measured by means of a 2500-v motor-driven megger, and the capacity in microfarads and dissipation factor were measured with a capacitance bridge. These readings were taken at the beginning of each group of tests and after every tenth successive test. The results of this test are shown in Tables I, II and III.

The reason for increasing in steps of 25 per cent rated voltage on this first "A" phase test was to find the approximate insulation level of the winding without spending too much time in numerous tests that might be far below the

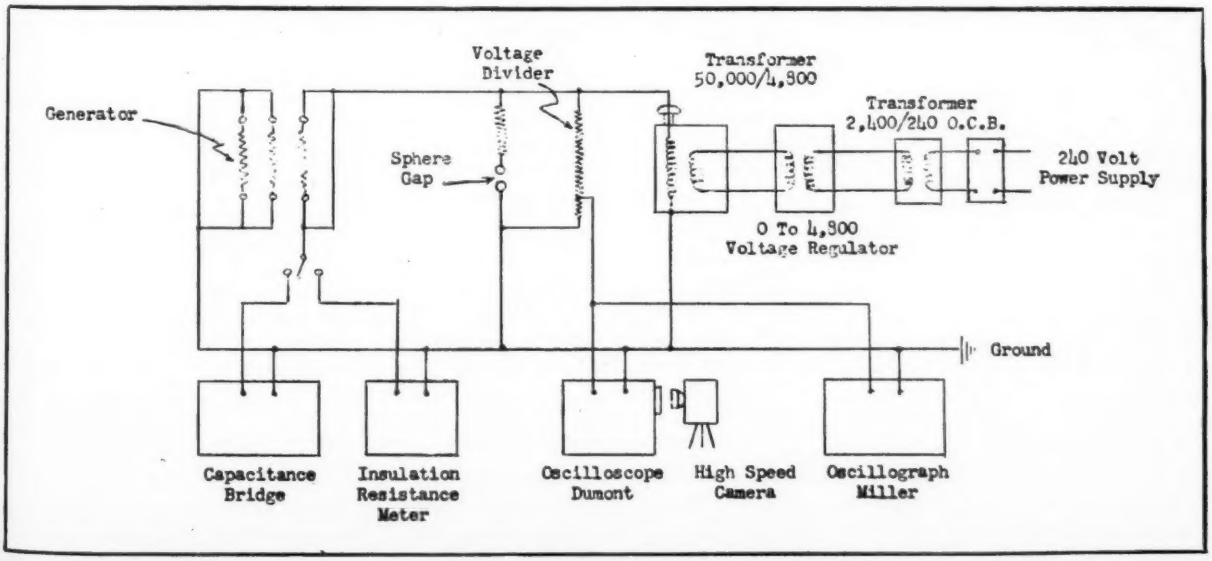

Fig. 1—Diagram Showing Arrangement of High-Voltage Test Equipment—Southern California Edison Company

level. After the 175 per cent tests it was decided to increase to 200 per cent plus 1000 volts. This value was used because it was thought to be of interest to see if the winding would stand a series of tests at the voltage applied on a new winding of this rating. On the one hundred and first application of voltage, failure occurred in Slot No. 68 at the top finger plate, fourth coil from the line. The megger reading showed zero, and no reading could be obtained with the capacity bridge.

It will be noted by reference to Table I that approximately 150 per cent of rated voltage was imposed on Phase "A" intermittently for fifty minutes, followed immediately by 175 per cent of rated voltage intermittently for another fifty minutes, not including the time required to build up or to remove the test voltage. Thus the winding was held at high voltage for a total time of one hour and forty minutes, with only momentary rest periods between each test, with no evidence of injury.

A change of insulation resistance from 7000 to 10,000 megohms was measured, but this is not considered significant. The insulation resistance recorded for the one hundredth test was the same as for the first thirty tests.

The change in winding capacity to ground changed from 0.157 to 0.165 microfarads, or 5.10 per cent.

The greatest measured change was in the dielectric dissipation factor. This increased from 4.0 to 6.1. This progressive increase in dielectric dissipation factor was noted in the subsequent tests on Phases "B" and "C." In the case of Phase "B" the dielectric dissipation factor went from 5.0 to 9.0.

Increase in Dissipation Factor

It is believed that this increase in dissipation factor was due to a slight increase in winding temperature as a result of the long application of high voltage, and is not indicative of permanent deterioration.

Attention is directed to the fact that after the winding had failed, and the megger reading dropped from 7000 to 2500 megohms, there was no change in dissipation factor. That means that an insulation power-factor measurement taken before and after breakdown would have indicated no change in the condition of the winding. It is considered further significant that with no knowledge other than the final megger reading and insulation power-factor reading, anyone would have approved the machine for service. The minimum insulation resistance recommended by the AIEE rules for this machine would be 330 megohms at 25 C. No standard has been established for maximum winding power factor.

In the Phase "B" test, Table II shows that the winding endured the high voltage intermittently for a total

TABLE I—REPETITIVE OVER-VOLTAGE TESTS—28,000-KVA, 11,000-V HYDROELECTRIC GENERATOR, "A" PHASE

Test No.	Test Voltage Applied Volts	% Of Rated Volts	Exc. Current Amperes	Duration Seconds	Megger Reading Megohms	Cap. To Ground M.F.	Dissipation Factor Percent
					5 Min.		
1	17,500	152	-	60	7,000	.158	
2 to 11	17,250	150	1.1	60 Each	7,000	.157	4.0
11 to 20	17,250	150	1.1	60 Each	7,000	.160	4.5
21 to 30	17,250	150	1.1	60 Each	7,000	.161	4.5
31 to 40	17,250	150	1.1	60 Each	10,000	.161	4.7
41 to 50	17,250	150	1.1	60 Each	10,000	.162	5.0
51	20,400	177	1.36	60			
52 to 60	20,150	175	1.34	60 Each	10,000	.162	5.1
61 to 70	20,150	175	1.34	60 Each	10,000	.162	5.1
71 to 80	20,150	175	1.34	60 Each	10,000	.163	5.9
81 to 90	20,150	175	1.34	60 Each	10,000	.165	5.9
91 to 100	20,150	175	1.34	60 Each	7,000	.165	6.1
101	24,150	210	-	6 Sec.	0	Could Not Read	

TABLE II—REPETITIVE OVER-VOLTAGE TESTS—28,000-KVA, 11,000-V HYDROELECTRIC GENERATOR, "B" PHASE

Test No.	Test Voltage Applied Volts	% Of Rated Volts	Exc. Current Amperes	Duration Seconds	Megger Reading Megohms	Cap. To Ground M.F.	Dissipation Factor Percent
					5 Min.		
1	17,250	150	1.1	60	7,000	.158	5.0
2	20,400	177	1.36	60			
3 to 11	20,150	175	1.33	60 Each		.162	5.3
12 to 21	20,150	175	1.33	60 Each		.163	5.3
22 to 31	20,150	175	1.33	60 Each		.164	5.5
32 to 41	20,150	175	1.33	60 Each		.165	6.0
42 to 51	20,150	175	1.34	60 Each	7,000	.165	6.0
52	21,650	188	1.49	60			
53 to 61	21,400	186	1.47	60 Each		.167	6.5
62 to 71	21,400	186	1.47	60 Each		.168	6.6
72 to 81	21,400	186	1.47	60 Each		.168	7.0
82 to 91	21,400	186	1.48	60 Each		.168	7.0
92 to 101	21,400	186	1.47	60 Each	7,000	.169	7.5
	AFTER AN INTERVAL OF ONE HOUR						
102	21,950	191	1.51	60			
103	22,700	197	1.60	60			
104 to 112	22,450	195	1.58	60 Each	7,000	.168	7.5
113 to 121	22,450	195	1.58	60 Each		.168	9.0
122	22,450	195	1.58	45 Each	Failed, instantaneous overload relay opened the oil switch.		
Failure of back coil in Slot No.36 at top finger plate, fourth coil from line					2,500	.168	9.0
Endeavored to clear the bad coil in Phase "A" by cutting clear with bolt cutters.							
123	17,250	150	1.08	20	Failed		

time of two hours. Breakdown occurred at 22,450 v, compared to 24,150 v in the case of Phase "A" which had been subjected to the high voltage for one hour and twenty minutes intermittently. The over-all time of intermittent high-voltage application for Phase "C" was only nine minutes, and the breakdown voltage was 25,600.

Thermal Effects

It might be thought from this series of tests that repeated applications of high voltage had weakened the winding. The evidence from the tests on this one generator however is not adequate to support that conclusion. It is recognized that the failure of insulation under dielectric stress in the range used in these tests is a function of time, shorter times requiring higher voltages.

This effect has been attributed to thermal effects. Such effect does not necessarily produce a permanent change in insulation, so that repeated tests separated by time sufficient to allow complete cooling to the initial state might not have shown different final values of breakdown voltage.

Furthermore, this is only one machine and some initial difference between the condition of the three phases may have existed. This relation between time and breakdown voltage did not occur in other windings tested. This will be seen by reference to Table V which gives the results of a similar test on a 17,500-kva, 6.6-kv generator.

Similar repetitive over-voltage tests were made on other machines before the old windings were removed for replacement. Data was accumulated for the following machines:

1—17,500 kva, 6,600-v hydroelectric generator.

1—17,500 kva, 11,000-v hydroelectric generator.

1—28,000 kva, 11,000-v hydroelectric generator.

2—30,000 kva, 6,600-v synchronous condensers.

1—50,000 kva, 13,200-v steam-electric generator.

As a result of repetitive high-voltage tests on these machines which were rewound, and from other studies of insulation failure, it was concluded that the application of 150 per cent rated voltage would be safe and satisfactory.

This procedure was put into effect in 1945. Since then a high potential test of one and one-half times rated voltage has been made at the beginning of each annual overhaul. As of today, a great many machines have received this test. A list of these is given in Table IV.

As can be seen from this tabulation, some insulation failures did occur during the over-voltage tests. When this happened, repairs were made as required and the test was repeated. To date there have been no cases of winding failures in service of machines which passed the over-voltage test. Included in this tabulation are two machines, one at the Laguna Bell Station and one at Big Creek Plant 2-A which were purposely tested to failure to obtain information for analysis.

Special Tests

Special tests were made on a 45,000-kva, 12,500-v hydroelectric generator to determine the effect on the wave shape of the test voltage during certain conditions of high potential tests on the stator winding.

The equipment used to supply the test voltage consisted of General Electric Transformer, 200 kva, 50,000-4,800 v; General Electric induction regulator, 100 kva, 2,400 v; Westinghouse transformer, 75 kva, 2,400-480/240-v oil circuit breaker, disconnect switch, 6.25-cm sphere-gap with current limiting resistors.

The scheme of connections was the same as is shown in Fig. 1.

Oscillograph Records

An oscillograph record of the test was made on Phase 1 with the sphere-gap connected in parallel with the generator winding and set to breakdown before the winding would fail. A 35,000-ohm current limiting resistor was used in series with the spheres. The oscillogram showed that, after the spark gap arced, there was no other disturbance than a slight decrease of voltage which was due to the regulation of the test transformer.

Another oscillogram was made under the same conditions as above except with the series resistor reduced to 18,000 ohms. Again there was no disturbance other than the drop in voltage while the spark gap was arcing over.

A third test was made on Phase 1 by building up voltage on the generator winding and then tripping the oil circuit breaker of the test transformer man-

TABLE III—REPETITIVE OVER-VOLTAGE TESTS—28,000-KVA, 11,000-V HYDROELECTRIC GENERATOR, "C" PHASE

Test No.	Test Voltage Applied Volts	Test Voltage Applied % Of Rated Volts	Exc. Current Amperes	Duration Seconds	Megger Reading Megohms	Cap. To Ground M.F.	Dissipation Factor Percent
					4,000	.158	4.0
1	17,250	150	1.12	60		.159	4.0
2	18,300	159	1.20	60		.159	4.0
3	19,300	168	1.28	60		.159	4.5
4	20,350	177	1.38	60		.158	4.5
5	21,400	186	1.47	60		.160	4.8
6	22,450	195	1.57	60		.161	4.8
7	23,500	205	1.67	60		.159	4.8
8	24,600	214	1.78	60		.160	5.0
9	25,600	223	1.87	20	Flashed over at coil term.		
Built up to 23,500 volts before flashover. After trying to insulate at point of flashover, built up to 25,600 volts and held for twenty seconds before flashover.							
Built up again to 25,600 volts, flashover in five seconds.							
Made repeated tests at lower voltage.							
10-49	22,450	195	1.57	60 Ea.	Not taken.		
50	24,000	209	1.74	60	Not taken.		
51	24,000	209	1.74	30	Flashed from puncture in insulation to finger plate.		
52	24,000	209	1.74	20	Flashed from puncture in insulation to finger plate.		
Back coil in Slot No.103 about three inches above the iron. Puncture in insulation apparently occurred during the flashover in Test No.9 above.							

ually. The oscillogram for this case showed no other disturbance than the normal decay of voltage from the test set.

Phase 1 was again tested, this time with the spark gap opened wider. The voltage was built up to about 18 kv, and then increased rapidly to approximately 20 kv. A discharge took place in the top section of the stator winding, and observers reported a flash from the winding to one pole piece. The gap arced and maintained for several seconds. The oil circuit breaker was opened by hand. The oscillogram of this test showed that on the first cycle after the winding breakdown, the peak voltage was 22.3 kv. No further disturbance was evident.

Voltage was again brought up on Phase 1, and then the high voltage lead was grounded by means of a lead on a disconnect pole. After grounding, the ground was removed by drawing out the arc until it broke and normal voltage was again established. The oscillogram for this test showed an abrupt reduction in voltage when the lead was grounded, followed by a sustained voltage of about 1050 v at a very high frequency. No abnormal voltage peaks occurred. As the arc was drawn out, the oscillogram showed an increase in voltage across the arc and for each cycle there is indicated a high frequency following each voltage peak. The first cycle, after the arc was extinguished, showed a peak of about 3300 v higher than the normal voltage. After a few cycles at normal voltage, the test set breaker was manually opened and the voltage indicated the normal decay for this condition.

Tests on Phase 3

Phase 3 was energized from the test set and then voltage was gradually brought up to approximately 17.5 kv and then rapidly increased until the winding broke down and the oil circuit breaker opened automatically. The oscillograph record for this test indicated that there was a slight increase in voltage following the breakdown which collapsed to a very low voltage immediately. The same transient condition existed until the breaker tripped, as was the case where the generator was manually grounded, that is, there were several cycles of higher frequency voltage of very low magnitude displaced above and below the zero voltage line.

Early in 1945, during the annual inspection of a 66,667-kva, 11,000-v steam-turbine-driven generator, it was observed that many of the stator coils were loose in the slots. The original maple slot wedges had shrunk so much that they could be easily moved. Some of the coils had been moving radially as much as a sixteenth of an inch at each end of the core. The coil lashing had deteriorated and there was evidence of corona action on some coils. The gen-

Table IV—Over-Voltage Tests on Synchronous Machines

Station	Machine Kva	Rating KV	Date Of Test	Test Voltage KV	Percent Rated Volts	Charging Current Amperes	Remarks
Bundini - Condenser	10,000	15.0	3-31-47	22.5	150	0.57	One Minute OK.
Chino - Condenser No.1	60,000	13.8	2-18-49	20.7	150	1.76	One Minute OK.
Condenser No.3	60,000	11.5	1-28-49	17.3	150	1.55	One Minute OK.
Colton - Condenser	30,000	11.5	10-17-47	17.3	150	1.66	One Minute OK.
Condenser	33,500	12.0	3- 3-49	18.0	150	1.72	One Minute OK.
Eagle Rock - Condenser No.2	15,000	6.6	4- 9-46	9.9	150	0.28	One Minute OK.
Condenser No.2	15,000	6.6	11- 9-48	10.0	150	0.36	One Minute OK.
Condenser No.3	30,000	6.6	7-12-47	14.8	225	1.14	One Minute OK. New Winding
Highgrove - Frequency 60 Cy.	60,000	13.8	3-27-48	20.7	150	1.66	One Minute OK.
Frequency 50 Cy.	60,000	13.8	3-27-48	20.7	150	1.71	One Minute OK.
Katella - Condenser	10,000	11.0	2-19-47	16.5	150	0.60	One Minute OK.
La Fresa - Condenser	50,000	13.2	5-24-48	19.8	150	-	One Minute OK.
Laguna Bell - Condenser No.1	30,000	6.6	11- 6-47	10.0	150	0.57	Ten Tests 1 Min. Each OK.
Condenser No.2	30,000	6.6	1-30-48	9.9	150	0.74	One Minute OK.
Condenser No.3	30,000	6.6	8-18-47	9.9	150	0.86	One Minute OK.
Condenser No.4	50,000	13.2	11- 4-46	19.8	150	2.2	Phases B & C One Min. OK, Phase "A" broke.
Condenser No.4	50,000	13.2	11- 9-46	19.8	150	2.2	Phase A OK One Min. after repair.
Condenser No.4	50,000	13.2	2-25-48	19.8	150	2.6	One Minute OK
Lighthipe - Condenser No.2	60,000	14.5	11- 8-48	21.7	150	2.98	One Minute OK.
Condenser [illegible]	60,000	14.5	11-29-48	20.0	139	2.90	One Minute OK.
Lighthipe - Condenser No.3	60,000	13.2	9-15-48	17.3	131	2.66	Phases A & B OK One Min., Phase "C" broke down.
Frequency 60 Cy.	60,000	13.8	4-12-48	20.7	150	1.74	One Minute OK.
Frequency 50 Cy.	60,000	13.8	4-14-48	20.7	150	1.74	One Minute OK.
Mesa - Condenser No.2	60,000	13.8	2- 1-49	28.6	208	2.6	Two phases OK, one phase lead Failed (New Winding)
Condenser No.2	60,000	13.8	2- 8-49	28.6	208	2.6	OK after repair.
Rector - Frequency 60 Cy.	30,000	11.5	1-10-47	17.3	150	0.82	One Minute OK.
Frequency 60 Cy.	30,000	11.5	2- 6-48	17.5	150	1.32	One Minute OK.
Frequency 50 Cy.	30,000	11.5	1-10-47	17.5	150	1.00	Cable failed in duct, one Min. OK after repair.
Frequency 50 Cy.	30,000	11.5	2- 2-47	17.3	150	1.20	One Minute OK.
Frequency 50 Cy.	30,000	11.5	2- 6-48	17.5	150	1.32	One Minute OK.
Frequency 60 Cy.	30,000	11.5	4- 8-48	17.5	150	-	One Minute OK.
Frequency 60 Cy.	30,000	11.5	8- 9-48	17.5	150	1.08	One Minute OK
San Antonio Condenser	15,000	11.5	9- 3-48	17.3	150	0.82	One Minute OK.
Santa Barbara - Condenser	10,000	11.0	12-23-47	16.5	150	.72	One Minute OK.
Condenser	10,000	11.0	2- 4-49	16.5	150	.72	One Minute OK.
Saticoy - Condenser	15,000	18.0	3-23-49	24.9	139	1.16	One Minute OK.
Tulare - Condenser	5,000	12.0	2- 1-46	18.0	150	0.33	One Minute OK.
Vestal - Condenser No.1	15,000	15.0	11-22-47	22.5	150	0.75	One Minute OK.
Condenser No.2) Before	15,000	12.0	2- 4-49	28.5	238	-	"A" Phase broke down.
Condenser No.2) Rewind	15,000	12.0	2- 4-49	28.5	238	1.04	"B" Phase broke down.
Condenser No.2)	15,000	12.0	2- 4-49	33.0	275	-	"C" Phase broke down.
Condenser No.2) New	15,000	13.8	3-10-49	26.2	190	-	Brokedown to lead clamp.
Condenser No.2) Winding	15,000	13.8	3-10-49	28.6	208	1.4	One Min. Ok after repair.
Condenser No.3	15,000	18.0	10-26-48	27,000	150	2.24	Two tests 30 seconds each.
Condenser No.3	15,000	18.0	11- 2-48	18,000	100	-	Machine smoked, wet varnish
Vestal - Condenser No.3	15,000	18.0	11-16-48	27,000	150	2.25	One Min. OK after drying with heaters.
Big Creek 1 - Generator No.1	17,500	6.6	1-26-48	16.0	250	0.90	One Minute OK, New Winding
Generator No.2	17,500	6.6	1-15-47	16.0	250	1.10	One Minute OK, New Winding
Big Creek 2 - Generator No.6	17,500	6.6	2-13-47	16.0	250	0.89	One Minute OK, New Winding
	(45,000	12.5	12-22-48	17.5	110	0.34	One Minute OK)Before
				20.0	160	0.40	Intentional Breakdown)Rewind
	45,000	13.8	1-24-49	28.6	208	3.13	One Minute OK, New Winding
Kaweah - Generator No.2	1,200	2.3	3- 6-47	4.0	174	0.20	One Minute OK.
Kern River 3 - Generator No.2	17,500	11.0	11-27-46	25.0	264	1.78	Phases 1 & 3 OK,)New
							Phase 2 failed)Winding
Generator No.2	17,500	11.0	11-27-46	25.0	264	1.78	One Min.OK Phase 2)
Ontario No.1 - Generator No.1	250	11.5	9-23-48	25.0	218	0.82	One Min. OK, New Winding.
Generator No.2	250	11.5	9-13-48	25.0	218	0.86	One Min. OK, New Winding.
Long Beach - Generator No.1	15,000	11.0	4- 5-48	16.5	150	.72	One Minute OK.
Generator No.2	18,750	11.0	4- 5-48	16.5	150	.60	One Minute OK.
Generator No.3	25,000	11.0	7-30-47	16.5	150	.77	One Minute OK.
Generator 7-R		13.2	6-20-47	19.8	150	1.06	One Minute OK.
Generator No.10	100,000	16.5	3-13-47	25.0	150	2.70	One Minute OK.
Generator No.10	100,000	16.5	5- 8-47	25.0	150	2.85	One Minute OK.
Generator No.10A	5,000	2.3	3-13-47	3.5	150	0.01	One Minute OK.
Generator No.11	100,000	16.5	7- 6-48	25.0	150	..20	One Min. OK, before rewedging
Generator No.11	100,000	16.5	9-13-48	25.0	150	3.55	One Min.OK, after rewedging
Generator No.11A	5,000	2.3	7- 6-48	3.5	150	0.01	One Minute OK.
Redondo - Generator No.1	70,000	13.8	2-20-48	28.6	208	1.65	One Min. OK, New Winding.
Generator No.2	70,000	13.8	4- 2-48	28.6	208	2.20	One Min. OK, New Winding.
Vernon - Generator No.2	7,500	7.0	7- 1-47	10.8	150	0.32	One Minute OK.
Generator No.3	7,500	7.0	6- 9-47	10.8	150	0.32	One Minute OK.
Generator No.4	7,500	7.0	8- 1-47	10.8	150	0.32	One Minute OK.

eral condition of the winding appeared good, however, and it was decided to make minor repairs at this time and to prepare to rewedge the machine and make permanent repairs in 1946.

The machine was tested at 150 per cent of rated voltage between each phase and ground, found satisfactory, and was returned to service in March, 1945.

The generator was operated without trouble until the scheduled overhaul in May, 1946. The material for rewedging and making permanent repairs had been secured. After the winding had been rewedged, one phase failed on the 150 per cent over-voltage test, and it was necessary to remove about twenty coils to replace the defective coil with a spare coil. After all coils were installed, wedged, and lashed, a final test of 15,000 v was given all phases. No breakdown occurred, and the unit was returned to service.

Careful examination of the defective coil, and comparative tests on the spare coil, indicated that the winding was actually seriously deteriorated. It was then decided to plan for a complete rewind in 1949, when this unit would be out of service for conversion from fifty to sixty cycles.

Further Tests

Advantage was taken at the time this machine was shut down for rewind to conduct tests to determine whether or not transient voltage was produced at the machine terminals as a result of the flashover of the sphere-gap used in parallel with the machine winding. The Edison Company has always followed the procedure given in the AIEE Standards No. 4, Paragraph 7 of the appendix, for performing dielectric tests on machines with windings having a large capacitance.

It was believed if the spark gap flashed over while the voltage calibration was being made, that the machine winding might receive an impulse of voltage higher than desired. Since it was also thought that this voltage surge might be too short a duration to be registered with an ordinary oscillograph, arrangements were made to obtain high speed pictures of the test wave form at the instant the gap was flashing over.

A circuit making use of the fact that the impedance of a capacitor would be abruptly altered at the instant of sphere-gap flashover was used to produce voltage for triggering the oscillograph.

For the flashover of the 6.25-centimeter sphere-gap without the generator winding connected to the test equipment, the oscillogram showed a practically smooth voltage wave during the period of gap flashover.

For the flashover of the 6.25 centimeter sphere-gap, with the winding connected to the test equipment, the oscillogram showed the same smooth voltage wave as without the machine. There was no evidence of oscillation or high-voltage impulse caused by the gap flashover either with or without the machine connected.

It is possible that the capacitance of this machine did not have a value which would produce oscillations.

Because of the necessity to change the voltage of a 17,500-kva, 6,600-v hydroelectric generator, it was decided to conduct tests on this machine in order to further study the effect on the test wave form of a spark gap flashover due to breakdown of the calibrating sphere-gaps. At this time the windings were tested to failure by repeated applications of high voltage and measurements of power factor, dielectric loss factor, and insulation resistance were made. The results of these tests are given in Table V. This machine had a sixteen-pole, two-circuit wave winding with single turn coils.

The arrangement of the test equipment was similar to that shown in Fig. 1.

The machine winding was then connected for high potential test and the voltage built up until the spark gap arced over. The oscillogram indicated that the shape of the voltage wave had

TABLE V—REPETITIVE OVER-VOLTAGE TESTS—17,500-KVA, 6600-V HYDROELECTRIC GENERATOR

Test No.	Phase	Test Voltage Applied Volts	Test Voltage Applied % Of Rated Volts	Exc. Current Amperes	Duration Seconds	3 Min. Megger Reading Megohms	Capacity To Ground M.F.	Dissipation Factor Per Cent
0	A	-	-	-	-	3200	0.840	2.01
1	A	10,000	150	-	2	-	-	-
2	A	11,600	176	-	2	-	-	-
3	A	14,200	215	-	2	-	-	-
4	A	14,000	212	-	10	-	-	-
5	A	14,000	212	-	10	-	-	-
6	A	14,000	212	0.58	60	3600	0.840	2.20
7	A	14,000	212	0.58	60	-	-	-
8	A	19,800	300	-	1	Winding Broke Down 0 Could Not Measure		
0	B	-	-	-	-	3200	0.842	1.96
1	B	14,200	215	0.75	60	4000	0.842	2.04
2	B	14,200	215	0.75	60	4800	0.843	2.05
3	B	14,200	215	0.75	60	4900	0.844	2.01
4	B	14,200	215	0.75	60	5000	0.845	2.06
5	B	14,200	215	0.75	60	5000	0.844	2.02
6	B	16,500	250	0.88	60	5500	0.842	2.05
7	B	16,500	250	0.88	60	5500	0.842	2.03
8	B	16,500	250	0.88	60	5000	0.845	2.07
9	B	16,500	250	0.88	60	4800	0.842	2.05
10	B	16,500	250	0.89	60	4500	0.845	2.05
11	B	18,500	280	1.01	60	4500	0.843	2.02
12	B	18,500	280	1.01	60	4000	0.845	2.05
13	B	18,500	280	1.01	60	4000	0.845	2.12
14	B	18,500	280	1.01	60	4000	0.846	2.05
15	B	18,500	280	1.01	60	3900	0.845	2.09
16	B	19,500	295	1.08	60	3500	0.852	2.14
17	B	20,500	311	1.14	60	3600	0.855	2.07
18	B	21,500	325	1.20	60	3400	0.855	2.14
19	B	22,500	340	1.26	60	3000	0.855	2.10
20	B	23,500	356	1.37	60	2500	0.855	2.11
21	B	24,500	375	1.43	60	2300	0.855	2.16
22	B	25,500	386	-	1	1550	0.855	2.05
23	B	21,000	318	-	1	0	Could Not Measure	

NOTE:
1. During test No.18, corona was visable near finger plates.
2. On test No.19, and all subsequent tests, static discharges in streamers one inch long were jumping from Phase "B" winding to the rotor.
3. On Test 22 "B" Phase broke down to "C" Phase, then to ground.
4. After failure on Test 22, voltage was built up to 21,000 before break down. After Test 23, winding showed solid ground.
5. Phase "C" could not be tested because it was involved in "B" phase failure.

been distorted and peaked by the machine winding. Beyond the point at which the spark gap arced over, there was a reduction in voltage due to the voltage regulation of the test equipment and the wave form was more nearly that of a sine wave. These records show that the breakdown of the gap occurred without impulse voltages and without oscillations.

The winding was next tested to failure. Records of the test voltage before, at the time of, and after machine winding failure were made. At the time the machine winding broke down, the voltage immediately fell to a low value, but some oscillation did exist. The winding was not solidly grounded as was evidenced by the voltage building up and breaking down with minor oscillations every one-half cycle.

An examination of Table V shows that in this case the Phase "B" which received the greatest number of tests, failed at a much higher voltage than Phase "A." This is the reverse of the case discussed previously.

Table V also shows that there was no measurable change of winding power factor, nor any significant change in the dielectric loss factor. Although changes in insulation resistance were measured, they furnished no indication of impending breakdown.

These data confirm conclusions reached by the AIEE Committee on Electric Machinery and given previously in this paper, namely that no consistent relation between insulation resistance and dielectric strength has ever been found.

In large machines most of the failures are faults from coils to ground or between coils. Incipient weakness of this kind can be found by over-voltage tests. However, sometimes trouble begins by turn-to-turn faults within a coil. This type of trouble is very difficult to detect with presently available field test equipment. In this respect, machines with single turn coils are advantageous. Of course, if the coil is deep, single turn coils must be adequately transposed. The transposed conductors must be insulated, but the voltage between conductors is low and not likely to cause breakdown. Progressive breakdown of the insulation on transposed conductors will show up by evidence of local heating before serious damage will occur.

If an insulation breakdown takes place from coil to core in a machine solidly grounded, the iron may be burned and so greatly increase the work and time required to make repairs.

A number of tests have been made to establish the relation between dielectric breakdown using direct current versus alternating current (Electrical Engineering Volume 60, No. 12, Page 1009). The objective was to determine if comparable results could be obtained by using low capacity d-c testing equipment on large armature windings. The results of these tests indicated a ratio of d-c to a-c breakdown voltages of approximately 2.5 to 1.

There is considerable doubt as to whether the d-c test is comparable even if a fixed ratio of d-c to a-c breakdown values can be established. The mechanism of failure in the two cases is probably not the same. When an alternating potential is used, the voltage gradient is determined by the dielectric constants of the material. If direct potential is used, the voltage gradient will be determined by the series conductivity. If the insulation tested consists of a series of material with different dielectric constants, failures may take place on a-c that would not have occurred with d-c. In the a-c tests at high voltage, considerable charging current flows, and this may accelerate thermal effects.

At the present time it is believed that the a-c potential tests are more representative of actual conditions of operation, and furnish the best available method, when combined with careful inspection, of minimizing failures in service.

At this date most of the synchronous machines on the Southern California Edison Company System, whose windings were in doubtful condition, have been rewound with the latest Class "B" insulated windings.

Not many more opportunities will remain for testing windings to destruction. Further tests and studies will be made on the few machines remaining to be rewound. It is hoped that other utilities will continue the work along this line that has been started by this Company.

Part II of this paper, entitled "Operating Experience With Ungrounded Neutral," will be presented in a later issue of the EEI BULLETIN.

Revised Terms for Planned Lighting Awards Issued By EEI and Better Light Bureau

REVISED terms for the Planned Lighting Awards, which offer a total of $1400.00 in cash prizes and plaques to electric utility operating companies and their personnel for outstanding records in lighting promotional and educational activities during 1949, have been announced by the Edison Electric Institute and Better Light-Better Sight Bureau, sponsors of the awards.

A grand prize of $500 and a plaque will be awarded to the electric utility achieving the greatest success in the commercial, residential and industrial lighting markets combined.

Three equal prizes, each of $150 and a plaque, will be presented for the best records in commercial lighting promotion. Two similar prizes are offered for residential lighting activities and one prize, also $150 and a plaque, for industrial lighting promotion.

"It is believed that this emphasis in the Planned Lighting Awards upon commercial and residential lighting corresponds closely to present possibilities in the lighting markets, and to the proportion of effort now being placed in the various lighting fields by the average electric company," it was said by Harry Restofski, Chairman of the EEI Commercial Division General Committee.

Entries in the contest will be limited to lighting sales promotional-educational activities conducted during the calendar year 1949, Mr. Restofski said. The Planned Lighting Awards will be presented to winning companies and individuals at the 16th Annual EEI Sales Conference, Chicago, April 4-6, 1950.

Complete terms for the 1949 Planned Lighting Awards are now being distributed to the industry, Mr. Restofski said.

Training Programs Designed To Meet Nine Objectives

By A. H. Nielsen
Director of Training, Wisconsin Electric Power Co.

A paper presented before the Industrial Relations Committee Meeting, EEI, Milwaukee, Wisconsin, May 19, 1949

TRAINING activities at Wisconsin Electric Power Company are designed to meet the following objectives:

1. Introducing new employees to their jobs.
2. Developing the required skill of workers for the job.
3. Prepare employees for advancement.
4. Improving foremanship and supervision.
5. Increasing the effectiveness of the sales forces.
6. Improving public relations by training employees in the best methods of handling customer contacts.
7. Acquainting employees with personnel policies, safety and health.
8. Maintaining employee interest and morale.
9. Providing training aids and services.

The maintenance of an effective work force involves three important factors: (a) Careful selection, (b) Adequate training, (c) Good supervision. Every organization performs all three functions.

It is not a question of do you select, do you train or do you have supervision. The point in question is do you select *carefully*, do you *adequately* train and do you furnish *good* supervision.

Training programs in industry are most effective when people are selected who can benefit from the training. This pre-training consideration together with supervision that uses the results of training is a three-part team that builds a better organization. While this presentation deals primarily with training programs, it must be remembered that training alone is not enough.

Introducing New Employees to Their Jobs

Selecting the worker for a certain job and bringing him to a point where he can do his work quickly, correctly and conscientiously are two different items. In order to bridge the gap we need to introduce, first of all, the worker to his work. We must impart that information, that confidence and that point of view to transform him from an accepted applicant, who is usually ill at ease, into a capable worker, confident and interested.

Aids for the New Worker

There is no sharp line of demarcation between selection as a process and the introduction of the worker to his work. The two overlap. During the process of selection, the employment interviewer will impart information about the company and the jobs available as will enlist the interest of the applicant. The process of introducing the worker to his work, of getting him properly adjusted to a new situation, naturally takes place after the actual selection of the worker is completed. The following are the devices and aids used in the company:

1. *Employee Handbook.* This is an illustrated booklet which follows the pattern of giving a brief history of the Company together with information about jobs and the benefits that accrue from employment.
2. *Departmental Handbook.* Some departments have handbooks that give specific information about the jobs and working conditions that exist within the department which supplement the general employee handbook.
3. *Suggested Induction Outline* for foremen and supervisors was developed in the foremanship program to suggest items to be taken care of by the supervisor and his assistants. It is a two-page schedule which indicates what is to be done, when, where and by whom. Some departments have expanded this to include more specifically what each supervisor is to do for new employees.
4. *Screen Tour* of company property is available to any department by the training division. This is a half-hour lecture with slides giving a quick picture of the company's physical property and its services to the public.
5. *Employee's Handy Folder* is given to each new employee when initiated into the Employees' Mutual Benefit Association. This booklet describes the major medical, hospital and pension benefits available to members of E.M.B.A.

Developing the Required Skill of Workers for the Job

Learning by Doing—The doing of a job is the most effective means for learning. The supervisor, therefore, becomes the ideal instructor. All foremen and supervisors have taken the Job Instruction Training program developed during the war. All new supervisors who have been appointed since the war have taken J.I.T. Training the supervisor to train is an important activity for training on the job. Some departments require all of their supervisors to prepare and use job breakdown sheets for all training jobs.

Introductory Programs have been set up for accounts information and credit clerks. This is a fourteen-day vestibule-type training activity. The training division prepares a schedule for each day showing the time and the supervisor who is to do the training. As many as 15 supervisors in the Customers' Accounting Division are involved. Each supervisor, provided with a teaching plan for his part, conducts a brief examination when his training is completed and the trainee moves to the next step. Each supervisor involved evaluates the trainee and sends a rating report

to the Employee Training Division. When the training is completed, a report goes to the Controller with a summary of all ratings.

Training Meter Readers—A complete manual of meter reading activities and a schedule of training is set up for meter readers. This training involves classroom and field work. A meter reading test determines the achievement of the meter readers when the training is completed.

Training Manuals have been prepared for most of the Customers' Accounting jobs, such as billing clerks, service order clerks, bookkeepers, collectors, etc.

Meter Reader Seminar—It so happens that every two months a complete day is available for the entire meter reader group. On this day the group is brought in for a one-day seminar. A schedule of activities which includes meter reading practices, public relations items, films and movies of interest is made up for each such seminar.

Key Punch Operators are trained in a vestibule-type program which involves high school students during their last semester in school. Five or six students are picked each February and put in training from 5:00 to 7:00 p. m. every Tuesday and Thursday and from 9:00 to 12:00 on Saturday morning. Upon graduation in June, those who have reached certain standards of performance are retained as key punch operators. These students are paid for their time in training.

Prepare Employees for Advancement

Power Plant Department Step-Up Program—Employees in the Power Plant Operating Division are trained for the job immediately ahead according to a planned arrangement. The first step is for a trainee to be moved up one notch to receive training. No increase in rate is provided during this training period. When the trainee is proficient enough to do the job under normal conditions he is classified as qualified limited (Q.L.) and is available for step-up whenever a temporary vacancy occurs above him.

When an operator up the line fails to report for work, a person is stepped-up to fill the gap and step-ups are made all the way down to the lowest job in the progression. After a sufficient number of hours have been put in on the job ahead, the employee is certified as (Q.), qualified. When he is stepped-up as a qualified worker in the job ahead he builds up credit toward service pay increases. This plan avoids calling in men in the higher brackets and provides an opportunity to train people all along the line.

Related Training Program — This program was started in 1920 and has been in continuous operation since. It is really an evening school program which offers courses of study in a great variety of subjects, such as transformer connections, boiler auxiliaries, electric control circuits, storekeeping practice, wiring codes, customers' accounting procedure, etc.

These courses are taught during off-time hours and are offered on a voluntary basis. Each course requires 75 per cent attendance at an average of 10 two-hour meetings. A trained instructor is provided for each course. Text materials are used as the basis for instruction, some of which are developed by the company and others are standard textbooks. During the 1947-48 season, 15 courses were operated with a total of 279 employees completing the courses.

Graduate Engineer Training Program—From 1920-1930 the company graduated 88 engineers from a one-year training program. The plan during this period was to provide six two-month work experience periods to aid the student in finding a place in the company and to help Department Heads select the engineers for a specific job in the department. From 1930 to the present time, it has not been possible to operate the program, but it is being reactivated at this time. A slight change is to be made in the one-year training program. The proposed plan, which will start this summer, is to include three training periods as follows:

8 weeks—basic training.
20 weeks—departmental specialized training.
24 weeks—division specialized training.

Evening and Graduate Courses

Outside Training Opportunities—Milwaukee has several outstanding training institutions. The Milwaukee Vocational School offers a wide variety of trade and technical courses, Marquette University and the University of Wisconsin have well organized evening course programs. Publicity is given to these activities among employees who are encouraged to take advantage of the offerings. For graduate engineers who enroll in a graduate school program, the company subsidizes their tuition to the extent of paying one-third of the cost on enrollment and one-third on completion.

Improving Foremanship and Supervision

Administrative Committee—A foremanship administrative committee was organized in 1940 which is made up of the principal assistants of the several departments of the company. The total membership of this committee is 25 people. It has a chairman and vice chairman elected each year by the group. This committee plans the program of supervisory training for the entire company. It also serves as a sounding board to get supervisory reactions to any personnel problem that arises. Minutes are kept of all of its meetings. It meets once a month during the entire training season.

Introductory Foremanship Training—All newly appointed supervisors are appointed by their Department Heads to attend the meetings held in this program. Meetings are held one full day per month from October to May, inclusive. Six hours of classroom hours are scheduled for each day. A great many visual aids are used in this program to keep things moving and to provide variety in the activities.

The general plan for the program is to discuss foremanship fundamentals during the first three hours using a supervisory development sound-slide film program. In the afternoon three-hour period, highlights of the foremanship training program, which has been conducted over a period of years for all of the regular foremen, are presented in brief form. Company information, public relations, basic economics, human relations are subjects that are covered in the afternoon sessions.

Supervisors can come into the program at any time during the year and drop out when they come to that meeting in the following year. They get a certificate in the form of a small booklet which summarizes in brief, the pertinent foremanship principles covered in the course. At graduation time, a luncheon is arranged with the President of the Company who issues the certificates and invites the new supervisors into the regular foremanship program. All of the foremanship training is on company time.

Regular Foremanship Program — A conference-type training program for foremen was started in the Company in

1921. It was on a departmental basis until 1933 when the program became company-wide and on a continuous basis. From 1933 to the present time there has been conducted, for all foremen and supervisors, monthly conferences to discuss and evaluate a great number of topics. The general pattern which has evolved in this regular program is as follows:

October—General Assembly
November—Conferences
December— "
January— "
February—Departmental Assemblies
March—Conferences
April— "
May— "

Except for the general assembly and the departmental assemblies, the conference meetings are held during one week of each month in which 450 foremen are divided into 15 separate groups. A conference leader is provided for each meeting, who conducts the conference according to a leader's plan. A newsletter is issued to each foremen, following each conference, which summarizes the material covered and furnishes information of interest on a wide variety of subjects.

Management News—This is a special bulletin which reports matters of interest to the supervisory personnel which is not made available to them through other communications systems. It is information that needs to be given to foremen promptly on matters of vital interest to them. For example, during the period in which contracts are being negotiated, foremen and supervisors are kept informed on the progress that is being made. Other management decisions that need to be released to foremen promptly are issued through this type of bulletin.

Increasing the Effectiveness of the Sales Forces

Conferences are held with the several Sales Department groups as needed to keep sales people informed and stimulated to do good sales work. In several of these conferences, manuals have been developed to provide a standard story on the electrical appliances for the home.

For example, the refrigerator sales people developed a manual which tells the story of food preservation. By having the salesmen develop their own manual, differences in manner of presentation are ironed out so that all our people will tell the same story and tell it correctly. The EEI sales training course has been conducted for all sales people and is now offered to the dealer salesmen in our territory.

Improving Public Relations by Training Employees in the Best Methods of Handling Customer Contacts

A Service Committee has operated for many years to discuss the customer contact activities in the Company. One of its functions is to plan a program of training which will stimulate interest in doing a good job in dealing with customers, furnish information on electrical living, and keep employees informed on the activities of the electrical industry. Outside speakers are frequently brought in to emphasize the importance of handling customer contacts. The people enrolled in this program include the following groups:

Collectors
Meter Readers
Service Engineers
Purchasing Office Personnel
Appliance Repairmen
Merchandise Sales Clerks
Telephone Operators
Cashiers
Correspondents
Forestry Crews

Use of Films

Films are frequently used for meetings of these groups. The Dale Carnegie sound-slide film program and the sound movie "By Jupiter," are examples of the visual aids employed.

Telephone Institutes—A survey of the manner in which our telephone contacts are handled which was made by the Wisconsin Telephone Company, revealed some bad practices that had developed in the Company. A program provides for a three-hour training institute. All present employees who use the public phone for customer business and all employees who are promoted to such jobs are required to attend an institute.

During this three-hour period, training is given in several of the essentials of good telephone service. Each employee is given an opportunity to carry on a conversation over the phone and have that conversation recorded and played back so that the individual can hear just how his voice is heard by the customer. Bulletins, charts, and demonstrations are part of this institute.

Better Letter Bulletin—All correspondents who write to customers are furnished a bulletin once a month on some phase of good letter writing. This service is of a continuing nature.

Acquainting Employees With Personnel Policies, Safety and Health

Company Rules and Regulations on Employment Methods—All supervisors throughout the organization are furnished a manual of employment practices. This manual interprets, in many cases, the agreement between the company and its employees. It helps to get uniform interpretation of many personnel policies. The company prints in booklet form the contract for each of its unions and furnishes sufficient copies so that all employees can have the contract that applies to their jurisdiction.

Accident Prevention—Safety minutes, rule books, instruction cards, posters, and publicity in the company are the features of our accident prevention program. General foremen, as a rule, conduct safety meetings and use training devices that are furnished to them for their meetings.

One interesting aid is a number of safety graphs, published by the National Safety Council, which a foreman can use to call attention to some accident prevention topic. Sound-slide films and instruction cards are also furnished as aids to the promotion of a good safety record. All drivers of company vehicles are tested for their ability to drive and are given an approval card indicating their competency. Changes in traffic regulations are issued in the form of bulletins to all company drivers. The Association of Commerce in Milwaukee conducts several safety schools each year for which we solicit our employees for enrollment.

Maintaining Employee Interest and Morale

Rail and Wire—This is an attractive company magazine which is mailed to the employee's home each month during the entire year.

Employee Group Organizations—

(a) *Technical League.* This is a mens' club for all male employees of the Company. Four interesting meetings are held each year that provide an opportunity for management to appear and where subjects of interest to employees of a technical nature can be presented. At a recent meeting we had an opportunity to show movies of the construction

(*Continued on page* 320)

Foot Rules for System Planning

By R. G. Hooke
Public Service Electric & Gas Co., Newark, N. J.

A paper presented before the Electrical Equipment Committee Meeting, EEI, Chicago, Ill., May 2, 1949

TO the System Planning Engineer, perhaps more than to any other, is assigned the task of seeing the system squarely and seeing it whole. The composition must be in focus both geographically and chronologically, for day after day he must advise when what will be needed where.

Balance of Service and Cost

In the background, behind his recommendations, there is always a balance being drawn between service and cost. Customers are increasingly exacting in their requirements for reliable supply because they are increasingly dependent on electricity. Designers of lines and equipment have learned over the years how to make their products more nearly failure-proof; but still faults occur. Costly spare facilities must, therefore, be provided.

How much spare shall the Planning Engineer call for in the many elements of the system under his purview in order to satisfy the customers' demands for high grade service? What fault conditions shall he design to meet? Obviously, one of his major problems is to rationalize the margins by which capacities should exceed loads, remembering the old saw about what makes a chain strong.

Of course, he is concerned too about the adequacy of the voltage his customers receive. Regulation and flicker take their toll of his working hours; but quality in what he supplies is more susceptible to rigid mathematical analysis and definitive boundaries than is quantity, i.e., continuity.

Spare Capacity Margins

The purpose of this paper, therefore, is to offer a discussion of the margins of spare capacity required to assure reasonable continuity of electrical supply. I am sure that the rationalization of spare policy is much further developed in the field of generation than it is in the field of transmission and distribution.

Perhaps, this is because of the heavy cost of investment in spare generators, turbines and boilers; perhaps it is because the statistical technique seems to be more readily applicable to generating station situations. Whatever the reason, the fact remains that much able and convincing work has been done on problems of spare generator capacity, while only very little has been done in the field in which I have been asked to give you the results of our empirical and, to date, rather embryonic thinking.

The area which I am going to treat is one in which there are wide and no doubt well-founded differences of policy among utility companies. It is hoped that the philosophies and resulting practices of one utility may be of interest and may lead to valuable discussion of the practices of others.

Historical Development

First, it should be said that there is no substitute for experience. In the vigorous 1920's experience was our only guide. We knew that lines and apparatus failed and that if service was important we must always have one more line or one more transformer than was needed to carry the load. We put standardized ratings on the facilities and as loads grew, we maintained the one-unit-spare margin, adding to our systems by simple, arithmetic foot rules, with due regard for any unequal sharing of loads.

Then came the "dis-inflation" of the 1930's. We were more careful of our pennies. Much thought was given to methods of reducing the margin of spare in our plant. Interesting papers were presented, notably one by Mr. S. M. Dean of Detroit and one by Mr. W. G. Lyman of Pittsburgh. Efforts were made to determine what the community could afford to pay or would wish to pay to avoid an interruption of say one kilowatthour. In my own company, we evolved a new unit—"interruption kvah avoided"—and it was proposed that we compare the merits of each increment of system capacity on the basis of the investment cost, or the annual charges on the investment, per "interruption kvah avoided."

The emergency ratings we used in those days were conservative and the theory was that all loads above ratings would be dropped. The purpose of any new facility was to avoid having to drop a certain number of kvah. The number of "interruption kvah avoided" was determined in each case from probability studies based on the best available failure-rate information, load duration curves and seasonal variations of loads and ratings.

What Does An "Outage" Cost?

There were a number of difficulties with this process: (1) There was no agreed-upon measure of the value to the community of one "interruption kvah avoided," so we did not know how much to spend to save an outage; (2) The basic failure rates upon which the studies must be predicated were unconvincing because many elements of a utility system, unlike much of the telephone plant, cannot logically be reduced to statistical norms; (3) System operators ordinarily do not drop load whenever ratings are exceeded. They hang on and transfer it to other sources or drop voltage a trifle or find some other expedient not in the probability analyst's mathematical ken; and (4) The procedure in each individual case to justify new facilities is extremely laborious.

System Planning Inconsistencies

But these were not wasted efforts. They demonstrated major inconsistencies in our system planning. We were investing some $50,000 per "interruption kvah avoided" for spare substation transformer capacity above two transformer banks as compared with $258 for spare subtransmission above a minimum of two lines to every substation. This irrational disparity was, of course, due to the fact that the probability of transformer failure was much less than the probability of transmission failure.

The same design standard—namely, "always prepare for one outage"—had been applied in both parts of the system. These studies also enabled us to put differential dollars on the known fact that the number of units serving any given load has its effect on the probability and magnitude of interruptions and therefore on the value of the spare. In a typical underground subtransmission system, adding a third circuit when loads exceed the capacity of a single line costs about $200 per "interruption kvah avoided," as compared to $5000 when a fifth cable is added because loads exceed the capacity of three.

Engineering Close to the Line

In 1941 came the War with loads and more loads! WPB, OPA, OWU! We couldn't get materials and we couldn't get equipment, but the planners had new insight. They had a more rational view of spare margins, average loadings, normal life, economic life. They had learned to engineer closer to the line. They had to! Not once were we "too little or too late." By better use of facilities we were able to maintain conditions such that a normal outage—the outage we designed to meet—would not require that any load be dropped.

Recognizing the fact that in facilities normally only partially loaded, there is an inherent overload capacity which may be called upon in an emergency, we planned to put that capacity to work. For transformers we increased the "normal" ratings substantially and added a further "emergency" rating on the theory of using up during any 24-hour emergency 1 per cent of the life of the transformer.

Higher Loadings on Cable

A not-too-conclusive economic study of underground cable failures indicated that it was probably economical to take the useful life out of our cables more rapidly by higher loadings. The weak point in this analysis was the unreliability of a basic curve of cable life versus temperature. However, circuit ratings were liberalized and emergency allowances of from 110 to 125 per cent of normal, depending on expected loading prior to the emergency, were promulgated.

The opinion has been expressed that an emergency rating is too high only if failure actually occurs during the emergency; any load short of one which will produce immediate failure should be accepted.

With emergency ratings approaching this ceiling, new facilities are often required because normal loads exceed normal ratings. It follows that the objective should be to establish a combination of normal and emergency ratings which will use up the life of the device in whatever period of time will give the maximum economy, i.e., the lowest annual costs of operation.

Spares for Emergencies

Whether or not this philosophy is accepted *in toto,* we have today, in our growing substations and subtransmission networks, many situations where our normal capacity with all facilities in service, is less than the emergency capacity under which we still provide, according to the old rule, for loss of the largest unit. In the old sense of the word, in these situations there is no "spare" capacity which could be loaded on a "when, as and if available" basis. The "spare" is only available to meet an emergency.

Parenthetically, it may be noted that in the transmission system, this has come about in part because of the planned use of a single spare transmission circuit or pole-line for a group of sometimes as many as eight or ten substations, and in part because of higher emergency ratings.

This is the background with which we approached the problem of establishing some kind of standards by which those responsible for planning and design might be guided. We should like to be able to arrive at the simple mathematical probability of one kilowatthour of load being interrupted due to trouble in each specific system element. But our pennies do not fall either heads or tails; the ratings change, the system design changes, the failure-rates change; the pennies balance at innumerable angles!

The probability of failure of a cable or a transformer is rarely the same as the probability of a service interruption. Furthermore, even if the data for rigid mathematical analysis were available and the procedures were worked out, the manhours necessary to produce the answer could not be found in these high-pressure times.

Informal Foot Rules

The result was a largely empirical body of foot rules first set up informally by our Planning Group about two years ago. They have been a most useful guide and they have attained a status such that the simple statement that any plan does not meet our Service Standards, usually condemns it to oblivion.

Our thinking starts with the thesis that our present service is satisfactory—it must not be allowed to deteriorate; large expenditures to improve it are not justified. Over the five years ending December 31, 1948, our interruption statistics are as follows:*

No. of Customers Interrupted per year per 100 Customers Served.	38
Average Duration of each Customer Interruption—Minutes.	52
Average kvah lost per year per 100 Customers Interrupted...	67

Fundamental Empirical Assumption

This result has been achieved with all our planning based on what is our first and most fundamental empirical assumption:

1. *Preparation must always be made for forced outage of any single piece of equipment or any line or pole line.*

Wholly on the basis of experience, we decided that this was a satisfactory foundation stone for our edifice of rules. Through changing ratings and procedures, it had worked. We would plan on it for the future.

One other stone was needed, to define the unit of load we would be willing to drop and the conditions under which such outage would be tolerated. We found this too in our past experience.

4-Kv Distribution Circuits

In our 4-kv distribution plant we had for some years worked toward a definite standard in providing cutover facilities:

2. *If a feeder serves only two or three customers, it must be possible to restore one-half of any load dropped by outage of it within approximately three hours and all of the load dropped within approximately 12 hours.*
3. *If a feeder serves numerous customers, it must be possible to restore essentially all of the load dropped by outage of it within approximately three hours.*

These two rules establish an interruption tolerance which we believe is acceptable to our customers. They fix the size of the load we are willing to drop for any fault as that which may be served by a single distribution feeder. The great majority of our circuits are of 300-ampere capacity, although a few,

* Interruptions due to 1944 hurricane and 1948 sleet storms are omitted.

serving heavy individual customer loads, are as large as 600 amperes. Of course, we are guided by the impracticability of providing completely firm service to the thousands of customers on 2000-kva radial distribution lines.

Our radio troublemen can get open-wire lines back in service in a maximum of three hours, ordinarily very much less; if the faults are in underground portions of lines, cutovers to other circuits are maintained so that loads can be transferred in a like period of time. When this is not feasible, the secondary network takes over to provide firm service except for localized secondary failures or troubles on services.

Spare Substation Feeder

Perhaps the most important element in this distribution planning is the fully-equipped spare feeder position in the substation to which we connect an outgoing "tie feeder." The latter becomes a spider-like circuit, its legs reaching in many directions to points just beyond the underground, near-station lengths of numerous radial lines, thus covering against possible cable faults.

As a result of this practice, we frequently are able to load our distribution circuits to a point where the non-simultaneous sum of the peak loads on the fifteen or more feeders out of a large distribution substation is 100 per cent of the sum of the nameplate ratings of the individual circuits, excluding the spare.

Distribution Substations

These three principles also set the pattern for the use of any single-transformer substations and the related transmission by which they are supplied. We simply say that the service rendered must be as good as would be supplied by a distribution feeder and we provide cutover and backup facilities accordingly. Whether or not it is as good, we do not actually know as yet. We assume that it is, but we have not attempted an analysis based on the probability of outages of the component facilities on which service depends.

These small substations are very new on our system. We do not know what troubles we shall have with them and, while the line outage statistics needed for a probability study are obtainable, we doubt the reliability of the assumptions which would have to be made regarding apparatus trouble-rates.

The application of the unit-type substation, tapped to subtransmission lines, tends, of course, to convert the 13- and 26-kv lines into super-voltage distribution circuits. Obviously, here we have a grave possibility of service deterioration, for the load supplied from such a line may reach 12,000 or 15,000-kva and also the time required to repair faults may be very much longer than for lower-voltage circuits. Hence, we have established certain rules for the installation of unit-type substations:

Rules for Installation of Unit-Type Substations

4. *For loads above 2,000 kva (one feeder) and up to 6,000 kva (3 feeders), interruptions must be limited to the period required for operation of automatic, service-restoring apparatus capable of restoring all of the load interrupted. This would be a matter of one or two minutes at the most.*
5. *For loads above 6,000 kva (3 feeders) full automatic duplicate service must be provided; no interruptions are acceptable.*
6. *Any arrangement must permit effective coordination of fuses, automatic disconnecting switches, automatic breakers, and associated relays and controls.*
7. *Provision need not be made for faults on substation buses or on equivalent short-sections of lines.*

Rules 1 through 6 prevent the loading of a large number of small substations on a single 26-kv circuit in such a way that numerous customers might be interrupted for long periods by line or equipment failures. They force the planning engineers to guard against transformer failure by providing adequate backup on the low-voltage side of any single-transformer substation. This is usually accomplished by extension of the "tie feeder" from an adjacent large substation so that it can take over the entire load of the single-transformer installation if need be.

The picture again is one of multiple use of a single spare. Of course the line extension needed to provide the backup is, in most cases, readily obtainable by use of the copper released when the unit substation is placed in service. This copper is not available to carry other load, but the position formerly utilized at the "mother-substation" and the transformer capacity there are both released for other use.

The planning engineer must also, under these standards, provide transfer facilities for his unit-type substations, as soon as he connects more than one (assuming 2,000-kva rating) to any 26-kv line. He may either arrange an automatic throwover to an adjacent line, on another pole line according to our requirements, or he may call for automatic, no-load, sectionalizing devices capable of splitting the line and picking up all the load through good portions of the circuit. Our relay men have limited us to two such sectionalizing points in any through circuit.

Rule No. 7 has been the subject of very recent discussion. In most of our larger substations and in all of our switching stations, we do provide for bus faults, although often not to such an extent that we can carry the loads indefinitely with a complete bus section out of service. In small substations, we do not consider expenditures specifically for bus sectionalization and differential protection to be justified.

Size Limitations

This is the old matter of cost per "interruption kvah avoided." In practice, there is a size-limitation in the application of this rule. However, for small substations, it is considered fully acceptable, and it answers a series of questions which have to be answered in planning substation developments.

Provisions Under Extensive Repairs

There remains one more of these fundamental, though largely empirical, concepts, which, with its ramifications, guide our system planning engineers.

8. *If any facility may require more than one week for repairs, provision must be made for overlapping outage of any other facility.*

The ramifications of this rule are interesting. In a substation containing a synchronous condenser, the load on the transformers may be reduced very substantially by use of the condenser. Should the condenser require major repairs, however, it may be unavailable for a long time and there is probably no spare condenser which can be installed in its place. Meanwhile, a transformer failure may occur. Therefore, in determining when new transformer capacity is needed in the substation, no credit is taken for the load reduction normally resulting from the use of the condenser.

If, on the other hand, the reactive capacity is provided by banks of static capacitors, full credit is taken for the

load reduction which they accomplish because any failure of the installation can be repaired in a few days at the longest. Thus, the use of static capacitors delays transformer installations, but the use of synchronous condensers does not.

Transformers

As to the transformers, themselves, they are almost invariably three-phase units and, after a failure, emergency ratings apply on the remaining banks; but, even though it may take many weeks to repair the faulted unit, no provision need be made for a second failure because a stock of these units is carried and a replacement can easily be installed in less than one week.

Incidentally, emergency ratings for substation transformers are very liberal and we never allow loads to exceed them except for the brief intervals which may be necessary for an operator to start fan cooling in an attended substation with a non-automatic fan installation. We also use fans on circuit breakers to secure higher ratings and postpone installation of larger capacity facilities.

Subtransmission

In the subtransmission system, provision is made for the loss of two circuits on any double-circuit pole line located on a traveled highway. If the two circuits are on steel towers and shielded by higher voltage lines, however, provision is made for only one circuit out at any time.

The same factors as for substation transformers apply in determining the loads at which new subtransmission lines are required, *i.e.;* no credit is taken for the load carried by synchronous reactive capacity because of the possible long outage period, but full credit is allowed if static capacitors are installed.

On these subtransmission circuits, in addition to an emergency rating which is based on the load carried prior to any fault, we have a special, 2-hour rating which is applicable when loads can be transferred from a transmission network in trouble to another adjacent transmission group. No matter how large these transmission networks become, we never allow for overlapping line outages. This is in accord with Rule 8, since line outages can be repaired in a short period of time.

It may be said that in this policy we are in a marginal area. We do have occasional overlapping outages of lines in these networks, especially during lightning seasons or when some of the cables may be as much as 40 years old. However, the capacities of the individual supply circuits are always small in relation to the total load served by the group. Therefore, there are only a very few hours in the year during which overlapping outages are embarassing. (See discussion on Page 304.)

Bulk Power

It now remains to discuss the policies applied in the bulk supply portions of the system. Public Service is part of the Federal Power Commission's Area 5 which has a total installed capacity of 4,587,000 kw. In this area, it has been decided to plan for a reserve capacity equal to 15 per cent of the forecast load. This decision is based on studies of maintenance requirements and experience with forced outages, the summer maintenance periods being critical equally with the non-maintenance, peak-load periods. For the individual company the rule becomes:

9. *The total of installed kilowatt capacity shall not be less than the peak kilowatt load adjusted for load diversity and increased by 15 per cent.*

The peak load in the Public Service system in 1948 was 1,167,000 kw. The diversity adjustment was 23,000 kw. Hence, the spare requirement was 0.15 x (1,167,000 − 23,000) = 171,600 kw. and the installed capacity should have been 1,338,600 kw. We have 1,390,300 kw effective capacity.

Since our two largest machines have an aggregate capacity of 240,000 kw, we can meet our interconnection obligations without meeting the requirements of Rule No. 8; a generator may be forced out while another is undergoing a long overhaul (more than one week). From the system capacity standpoint, this is acceptable because 15 per cent of the load of the entire area (15 per cent of 4,193,000 kw = 629,000 kw, in 1948) is much greater than the sum of any two units. The capacity of our interconnection is adequate to make up any local deficit and Rule 9 supercedes Rule 8.

Reactive capacity is provided according to a similar rule except that there is no adjustment for load diversity because reactive interchange between interconnected companies is not contemplated or practical. Our forecast peak reactive demand in 1948 was 862,000 kvar, and our installed capacity about 1,000,000 kvar or 115 per cent of the load. (Actually the load reached 900,000 kvar; more reactive capacity will be provided this year in connection with a new generator.)

Here again the practice does not meet the requirement of provision for overlapping outage of the two largest supply units, two generators with aggregate reactive capacity of 150,000 kvar. However, the margin of failure is small and will disappear in future as loads grow while the sizes of the individual units installed to serve them tend to increase less rapidly. It is believed that this policy of providing for reactive demands on the same basis as for kilowatt demands, including 15 per cent spare, is relatively uncommon in the industry.

Typical Outage Conditions

The planning standards sketched in this paper apply without modification in designing the supply to our nine load areas, each of which is served from one or more bulk-supply stations. We do not provide for complete loss of such a supply source but we do provide for loss of any element in the supply and for overlapping outages if one or more of the elements may require more than a week for repairs. Typical of the outage conditions contemplated are the following, any of which may be either scheduled or unscheduled:

A. Single outage of any 132-kv transmission circuit, transformer unit or turbine-generator.
B. Simultaneous outage of any two 132-kv transmission circuits on the same tower line.
C. Overlapping outages of
   a. Two turbine-generators
   b. A turbine-generator and a transformer unit
   c. A turbine-generator and a 132-kv transmission circuit
   d. Two transformer units
   e. A transformer unit and a 132-kv transmission circuit.

Multiple Outages Not Simultaneous

A condition of the assumed multiple outages is that the second does not occur until at least a week has elapsed after the first, during which time any feasible relief measures may be taken. This limitation on the possibility of multiple outages is based on a mathematical analysis of the probabilities of transformer

failures in switching stations. While there has been some question about the adequacy of the data on which the study was based, the results are interesting and the study is therefore briefly described in an appendix.

Conclusion

In conclusion, it may be said that the matter of providing adequate and consistent or coordinated spare facilities in all parts of the system, from the customer to the coal pile, is one of the most interesting problems before the planning engineer. For the most part, I am certain that the answers given by all of us are empirical rather than the result of mathematical analyses.

The purpose in presenting this talk is to bring out on the table the policies followed in this field by one utility in the hope that others will have similar material to offer, both empirical and theoretical. In our company a deliberate violation of the standard rules I have discussed is only contemplated after very careful consideration of the circumstances. Having a relatively stable set of boundaries within which to design is a boon indeed to the engineer.

Appendix—Results of a Study of Spare Transformer Policy for Switching Stations

Over a period of some 17 years, the policy in planning spare transformer capacity in switching stations had shifted frequently. In most situations one spare bank (3 units) in active service and an idle, single-phase spare unit had been provided. However, at times the idle unit had not seemed required and in other periods planning had contemplated there being two idle single-phase units at certain sites. The problem was complicated by an uncertainty as to what ratings should be used to determine when new capacity was needed. In 1944, a mathematical study of the matter, using the probability theory, was made.

Failure Rate Assumed

At the time of this study, we had had 161,877 bank days of operation of our switching station transformers, each bank consisting of three single-phase units. The failure rate over the 17-year period covered had been very irregular, 21 faults occurring in the first five years as against 8 in the next 12 years. However, for the purpose of the study, all failures were assumed to be random occurrences and a failure rate of 1.8×10^{-4} faults per bank-day of operation was assumed as a basis for the investigation. The average repair time was taken as 50 days. (Information available for 26 of the 29 faults showed 47 days.)

If a spare single-phase unit is held available at the switching station as had been our practice, it takes 2 hours to replace a faulted unit with this spare. If such a unit is kept at a central storeroom, it takes up to 6 days to get it into service following a fault at any location on the system. We found a sharp, seasonal variation in the failure rate. Of course there is also a seasonal variation in the loads and in the ratings. Additional transformer capacity may be provided either when loads exceed normal ratings or when they exceed emergency ratings. Our design men said that their emergency ratings were applicable for not more than 24 hours and only in case of unavoidable failures.

The results of the study for a typical switching station are shown in the table below.

We decided that Case 3 was not acceptable, but that any of the others were satisfactory. The economics of the situation then obviously eliminated Cases 1 and 4. Hence, we decided to schedule transformer spare capacity at switching stations in accordance with Cases 2 and 5. If we load up to emergency ratings, there must be a spare unit on the site, as well as a spare bank, and in addition a spare in stock at the storeroom.

After Failure Ratings

Upon failure, emergency ratings apply on the remaining bank or banks including the spare bank, until the spare unit on the site replaces the faulted unit in the defective bank. Then normal ratings apply and if the repair is to take more than one week, we move a stock-spare to the station thus preparing for a second possible failure. If we did not move in the stock unit, only normal ratings could be used on the transformers remaining in service after a second fault. In a few situations for which we have no stock spare available, added facilities are now scheduled on the basis of normal ratings.

Possibilities of Dropping Load Due to Transformer Failures in a Typical Switching Station Having Three Transformer Banks and Various Allocations of Spare Capacity

Case	*Transformer Installation Schedule Determined By*	*Assumption as to Spare Transformers Provided*	*Expectancy of Having to Drop Load*
1.	Normal Ratings	One spare bank and one spare unit at the station.	0.35 sec./yr.
2.	" "	The same as Case 1 except that the spare unit is kept in a central storeroom to serve several switching stations. (Can be moved to any site in 6 days.)	54.4 sec./yr.
3.	Emergency " *	Same as in Case 1.	1.14 hr./yr.
4.	" "	One spare bank and 2 spare units, both at the station.	24.8 sec./yr.
5.	" "	One spare bank and 2 spare units, of which one is at the station and the second is kept in a central storeroom as in Case 2.	41.4 sec./yr.

* Allowable for 24 hours per emergency.

The Electric Utility Industry Is Meeting the Country's Growing Demands

By H. S. Bennion

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An address before the Sixteenth Annual Conference, Southeastern Electric Exchange, Boca Raton, Florida, April 13, 1949

THE ELECTRIC utility industry, with a history of nearly 70 years, has traveled over many rough and rocky, and sometimes swampy, stretches of road, climbing over or through many difficult engineering, financial, competitive and political obstacles. It scarcely ever has had smooth going.

The proceedings of the NELA show that in the late 80's and early 90's municipal ownership was a grave threat. About 22 years ago the Senate took up a resolution to investigate the power industry. From that time until well into the 30's there was disclosed an attitude of hostility and unfriendliness in a substantial part of the press and in educational circles, together with a lack of friendliness in many business circles and in much of the remainder of the press, that was not only surprising but shocking to many of the leaders of this industry. They had no idea how unfavorably many people were actually regarding them and their business operations.

Period of Punitive Legislation

It was a period of investigations and corrective or punitive legislative proceedings, followed by enabling acts and appropriations to put the federal government into the power business on a much larger scale than theretofore and to foster, promote and induce socialism on a local or regional basis on a scale to threaten the financial standing if not the existence of many electric utility companies.

At the beginning of this period the private companies were generating 96 per cent of the nation's power supply and distributing 94 per cent to ultimate consumers. That severe and protracted test of the fitness for survival of the electric utility companies has left its mark in their ranks and has affected in many ways their present position and attitude.

Today the surviving electric utility companies, and the great bulk have survived, find themselves facing two broad, sweeping movements of great significance not alone to their own future but to the future life and course of this nation. The first is the worldwide and deadly movement toward national socialism which has already engulfed much of the world and for the past twenty years has been making glaring inroads into many sectors of American business. The second great movement is the unprecedented rate of growth of power demand.

Electric Consumption Increase

In eight years the consumption of electricity in this country has doubled. This is an average annual rate of increase of 10.2 per cent compounded as compared with long-term growth previous to 1940 of less than 4 per cent per annum. In World War II there was considerable backing up of demand for service and considerable advance had been made in electrification. This was coupled with an unprecedented supply of American goods and materials to the rest of the world following the cessation of war.

Expect High Annual Load Growth

Although there is some sign of slacking off in this present rate of increase in most sections of the country, there is already so great a momentum in research, development and design of machines, and in development of processes to use electricity, and there is such a premium on labor saving, and so much value to the various classes of retail consumers in more uses of electricity that it is generally estimated that the normal annual load growth over the decade beginning with 1950 will be 5 per cent compounded. Some capable estimators think it will be somewhat higher than that.

This extraordinarily rapid growth in conjunction with the bar to plant expansion during the war years brought the margins of reserves and spare capacity in most parts of the country to the lowest levels since the early decades of the industry. Only the skill and watchful care of operating forces, the pooling of combined resources to the greatest possible advantage, the coordinating of schedules for overhauling equipment, and the working out of some adjustments with their customers enabled the companies to meet these spectacular demands successfully with a minimum of inconvenience to their customers and a negligible production loss in industry. The year 1947 was a little more difficult than 1948, though in both years the average margin was approximately 5 per cent, and load shifting and other curtailments at the time of peak loads necessary in some localities amounted to something under 1 per cent of the total national load.

Deceleration in Demand

This comparatively tight squeeze gave the proponents of more government spending, and also those who believe in socialism, some fuel for their flames which they proceeded to make the most of, and are continuing to do so even though events are rapidly drying up any justification for such clamor. As I stated before, the rate of increase has been flattening off in most sections for the past few months and there are signs that this process will continue and probably will spread further.

Where it looked six months ago that during the summer or December peaks of 1949 there might be eleven or twelve areas rather tightly squeezed for capacity, it now appears that only three or four spots will be somewhat crowded and, barring accidents, their neighbors should be able to supply any deficiency they may find themselves confronted with. If this present flattening off trend should spread much further, even that small number will be reduced.

From now on any area short of reserves will have little company to share its concern.

The electric utility companies in five years from 1947 to 1951 plan to add 21,000,000 kilowatts, which is 52½ per cent increase, and over 15,000,000 of these kilowatts are scheduled to come in this year and the next two. Delivery dates on heavy equipment are being shortened considerably by manufacturers. Units are being offered for delivery one to five months ahead of schedule. Reserves are already back to normal in some localities and it appears that this will generally be true a year earlier than could be predicted last fall.

Notwithstanding this magnificent achievement of the electric companies, the federal government is going ahead with power developments which would increase its present 5,000,000 kilowatts of installed capacity to 20,000,000 kilowatts by 1960. A 5-per-cent-compounded load increase would mean that the private electric utility companies by that time would have an installed capacity of approximately 100,000,000 kilowatts. Nevertheless, larger plans of federal government bureaus have been revealed which indicate further power developments to bring total federal government capacity to about 50,000,000 kilowatts. The bulk of this, however, is in the far West.

Trading Liberty Bit By Bit

But getting back to this worldwide sweep of national socialism, the progress of which in this country is generally recognized and acknowledged, as is also its menace to the economic system and political liberty of the nation. Notwithstanding the overhanging menace, it is the mood of the American people to trade liberty bit by bit for today's good living and for promises of future food and shelter. Every political party, every sector of business, every locality in the country is honeycombed with compromise of proven principles for preserving economic liberty and wellbeing. Each locality, every business, has its own little special benefit or handout from the federal taxpayer which it wants to retain or enlarge, and no common defense against the advance has made its appearance so far. Immediate concerns and desires have overshadowed any striving for long-range aspirations and desires. Prosperity appears to be built largely on heavy government spending for unbusinesslike, uneconomical and inefficient projects and operations at home and abroad, and, taking advantage of this situation, socialists skillfully plan to take over or effectively control the American productive economy including farming. Actually their plans are advanced by the votes of those who do not want socialism but want immediate good business or immediate advantage.

In the face of so broad and so sweeping a movement, it is now well recognized that every business in this land is, or needs to be, concerned with its prospects of survival and wellbeing. This applies to all business and to professional men as well. The doctors, for example, are present targets of the movement.

Struggle For Survival

In this struggle for survival, which is very much broader than any mere question of whether one or more key industries will be owned and operated by the government, what are the prospects for electric utility companies as compared with other kinds of business? I believe their prospects are good and can be made better, and I will state briefly my reasons for thinking so.

I have nothing to tell you that you do not already know, but my hope is to stir up your thinking with respect to how best your efforts can be directed and perhaps to strengthen your determination to carry on the fight and also perhaps to enlarge your vision as to how much the cause of preserving freedom in America rests on your shoulders and the excellence of your day in and day out performance in a very important field of commercial endeavor.

Public Awareness

None of you, I am sure, will question the fact that the electric utility company supplies a vital need to the territory it serves, but I wonder if you have realized how much your customers now feel their dependence on your service, how conscious they are of their reliance on electric power. I wonder also if you realize how much this feeling will be intensified in another ten to twenty years by the further developments in application of electric power which you are helping to place on foot.

The industry's small reserves of the past two years have given us a better gauge of what the public expects of us, what we must be prepared to supply, and what we cannot afford to fail to do if forethought, good engineering and sound financial management can make the accomplishment possible. When there are evidenced good and sufficient and readily understandable reasons, the public will accept an inadequate power supply or wait for extension of services, but its patience only lasts while real justification is apparent to it. After that, in the eyes of the public, such a failure becomes a cardinal sin for which there is no forgiveness.

Interruptions of service are treated in like manner. They are accepted in good part when the justification is evident and when exertions and performance in restoring service win and hold their approbation. The same principle will undoubtedly be true ten to fifteen years from now, but the idea of what are adequate measures and of what is good and sufficient justification will surely change with increased use of electric service and increased dependence thereon. This greater dependence will demand a corresponding advance in plant facilities, in organization and in methods to keep apace.

The Process of Socialization

Having pointed out how much our customers feel their dependence on electric service, it should also be pointed out that there is a general belief, and history tends to bear it out, that the more vital the need an industry supplies the quicker and more inevitably that industry will be socialized. But modern society has many vital needs and the list continues to grow longer. We have considerable company. Furthermore, there are other factors that play a large part in determining the course which socialism will take.

We may ask: What are the basic underlying conditions relating to any industry or to any company that invite or fail to repel the socializing process?

We know that though a body may be surrounded by disease germs it may be healthy enough to resist their finding lodgment. As a general proposition, a lack of ability to finance desirable or necessary expansions and improvements of service has been the proximate cause of government financing, and sooner or later government operation. But usually back of this step there has been a considerable history of acts of omission and commission that have contributed in part at least to this fatal lack of financial strength. Of course, the lack of finances may be due to causes beyond the power and timely measures of the

best of management and the most skillful engineering, but, often, in a specific case, an appraisal will show that over a long period of years there was a lack of forehandedness, a lack of aggressiveness, a failure to attract and develop and use leadership of character and caliber, years of neglect, avoidance of dealing with important weaknesses, deficiencies or difficulties, coasting, patching, compromising compounded, basic faults in the organization teamwork, poorly adjusted and applied price structures, indifferent or unaggressive sales planning and execution, lack of exertion or inability to meet new competition, inability to withstand or avoid the crushing weight of high labor costs, etc.

A Good Record of Service

What has kept a service vital to the public from being socialized? This question is of more concern and application to our present operations. Some of these causes, and I shall deal with basic factors because they are the determining ones in any long hard and general struggle, are: A good record of adequate, dependable, high quality service; character, capability and responsiveness of the individual employees from the president to the newest employee; keeping right on the job, a live and promising record of technical and commercial advances; a history of sound rate or price policies defensible against provocative comparisons or well-aimed competition; and, not to be disregarded, are a successful and open financial record; a general and well-established reputation for good leadership, for progressive spirit, for engineering and operating excellence and for responsible, willing and helpful participation in community affairs.

Socialism Strikes at All Business

People have demonstrated time and again that they like and are proud of leaders of character and standing in their communities, leaders who are sincere, straight-forward, energetic, resourceful, progressive and able to give a good account of their stewardship. Such leaders are the best possible insurance against the advance of socialism. These statements apply to all American business and, as I said before, all or nearly all business is under the same pressure of government control and taxation and the threat of being engulfed in socialism.

Having in mind these survival factors relating to all American business, let us look now more particularly at the chances for electric companies to escape socialism as compared with other segments of the business world. As I see them, the strongest points in our favor are as follows:

Our business has far to grow. There is much technical work yet to do. There is a big selling job to be accomplished. In both of these fields private enterprise, according to all recorded history, has an enormous advantage. It is outstandingly more effective than other types of enterprise. This is by far the most favorable factor on our side. We have and always have had a progressive commercial spirit, a driving urge to give our customers the advantage of every new and useful development. Socialism attacks most successfully the mature or back-sliding business.

We use a relatively small labor force and our engineering and organizing skill have not exhausted the full possibilities of saving manpower in our operations. We do not face the threat that labor costs have brought or may bring to many other industries.

Meeting Demands For Service

We are meeting the demands for service. It seems to me that the biggest and most encouraging augury for a long and successful future for the electric companies as a whole is the fact that after twenty years of powerful and merciless attacks they have had the financial credit, the public spirit, the capable and courageous leadership, the engineering skill and the energy and drive to launch a six-year program to add 52 per cent of their facilities at a gross cost equal to three-fourths of their fixed capital and that they are already half way through the huge undertaking, although the hardest half from a financing point of view lies ahead.

Financial Standing Improving

Their financial standing is improving steadily, and deservedly so, from deep and sound considerations and what is very important is that the facilities being built are highly efficient and well suited to render long years of useful and profitable service. We are not building something to meet immediate demand that must soon be scrapped or written off. It is well built and will serve our customers well for years to come. This holds true not only in the efficient power stations we are building but for the transmission and distribution lines and substations.

The efficiencies and economies effected are already manifesting their beneficial influence. Furthermore, we are faced with very little scrapping of older plants. The uses for peak load capacity, the possibilities of aerial warfare, however remote, make it good sense on the part of companies and regulatory authorities to keep in useful status plants with an economy rate of say two pounds of coal per kilowatthour. This would include about 90 per cent of our capacity in service at the end of World War II.

Spirit of Service

We have the spirit of service. We have long been through the fire of hostile criticism and attack. We are not self-satisfied and have little chance to get that way.

We work together better than ever before with all our individualism and pronounced diversity of views, a natural and I think desirable by-product of the initiative and resourcefulness of the free enterprise system. We are more aware of the fact that a weak spot anywhere, an invitation to an entering wedge in any part of the country, tends to make the rules, the public opinion climate, and the reputation for the industry everywhere.

We are more awake to the task of selecting, training and inspiriting personnel. It is men and spirit after all and not machines that supply the will to advance and the determination to survive.

Economy Conscious

We are economy conscious and we practice it. We do not cover up inefficiency and wastefulness with demands for more money to spend. Before we ask for rate increases we first comb over our operating costs to look for any drift away from efficient and sound economy.

Our financial standing is decidedly up from its low point and on the mend. Investors show good signs of turning toward the stability of electric utility stocks.

Our leaders are aware of their obligations to lay before regulatory commissions the need for earnings that will give fair return to investors. There is a better mutual understanding between company management and commissions on the basic questions relating

to investors, consumers and employees. Much of the recent rate history shows that.

We are fortunate in being supplied and stimulated by the most progressive, technically competent, resourceful and best informed manufacturers in the world.

Though we have yet far to go in many sectors, we have advanced substantially toward esteem and good repute with business rank and file and with the public. We are not envied or begrudged as we once were. Other businesses have seen our sorrows and humiliations. We have been getting our come-uppance for about twenty-two years now. Business today is much more cognizant of the fact that we are all in the same boat and has quit looking upon us as a bad boy who had it coming to him.

These basic and important factors lead me to feel strongly that as a group the electric utility companies have a far better than average prospect for surviving the onsweep of socialism in this country. I think we have more of the important ingredients for survival from socialism than is true of most other important industries.

Record of Resistance

The resistance record so far of the electric utility companies, I believe, is encouraging if full account is taken of the powerful force of the destructive measures that have beaten upon them. After fifteen years of loans, grants, subsidies, acquisitions, adverse legislation, orders, regulation and judicial decisions, electric utility companies in proportion of total sales to ultimate consumers have dropped only 9 per cent. Where they formerly sold 94 per cent of all kilowatthours to ultimate consumers in this country, they now sell 85 per cent. That this loss has not been much larger has been due principally to the devotion of management and employees to the principles of a free economy and the willingness of investors and directors to take a long view of their financial interests and responsibilities and the contributions they were in a position to make to the preservation of economic and political freedom in America.

How long will this drive for socialism last? The price of freedom, we are told, is eternal vigilance. The struggle for technical improvement and commercial expansion must go on always if we are to keep in the vanguard of progress. Retrogression sets in the moment this struggle ceases.

The movement toward socialism has been gaining momentum for several decades. World War II helped and hurt the cause of free enterprise. The progress of socialization reduces the tax rolls and enlarges the clamoring needs of government agencies for more money. Surely one day there must come a sharp showdown on federal spending and on the fiscal position of the Federal Government which will choke off the appropriations, reduce the subsidies, spread more widely the tax burdens and halt the growth of socialization by reducing the tax money it grows on; but the United States is a big and powerful nation and no one can say when finances will force such a change. I have heard estimates of five, ten, fifteen and twenty years before federal finances will bring the issue to a head.

In the meantime, undoubtedly many more businesses and companies will have fallen to socialism. It seems to me, however, that if the electric utility companies take full advantage of their capabilities and opportunities and resolve to endure to the end, they will fare far better in withstanding this baleful disease than most other businesses. The struggle is surely worth the alternative cost. We were given a great heritage by those who went before us. Surely we owe it to those who will come after us to do everything reasonably within our power in our time to pass it on to them unimpaired.

It seems to me that the severest tests to the electric companies will come in the old form of moves for municipal ownership, for public utility districts and other such government creations where the real consideration will be the familiar problems of balancing tax avoidance by government operators and other such special privileges, on the one hand, and good service and local tax payments on the other. I am sure also that the best insurance for each company against such danger ever arising in its service area is a big and genuine credit bank of local public esteem constantly renewed and built up.

You will observe that in this discussion I have said nothing about the important subject of publicity, local or national. Experience has caused me to appreciate and value their importance, but it has also given me an appreciation of the greater importance of the performance and spirit of an industry or a company. I have found that it is much easier to tell a good news story if you have a good news story to tell. For that reason, in this talk I have stressed performance, attitude and character.

From a publicity standpoint, there is a tide in the affairs of a leader, a company, and industry, or even a government agency. When the publicity tide is running against you everything seems to conspire to drown out your voice, and it gets little or no heed. I think I have observed a change in the run of the publicity tide. I and my associates are called upon from many quarters for information for publicity purposes and in recent years we have noted an increasingly favorable attitude toward the electric utilities.

Planned Lighting Promotion Committee Formed By EEI

A National Planned Lighting Promotion Committee, which will keep the electrical industry throughout the country informed of new developments in Planned Lighting sales activities, is being formed by the Edison Electric Institute.

The new committee, which will be headed by J. S. Schuchert of the Duquesne Light Company, Pittsburgh, Pa., will be organized on a regional basis, with every section of the United States being represented by a leading figure in lighting promotion.

"This committee will serve as an active clearing house for successful Planned Lighting promotional and educational ideas used in all markets by the various branches and trade associations of the electrical industry, including manufacturers, distributors, contractors, dealers and utilities," Mr. Schuchert said. "Each committee member will sparkplug Planned Lighting activities in his assigned area, acting as the source of new P/L promotional ideas and continually pointing up the long-term benefits resulting from aggressive Planned Lighting promotion to customers and companies alike."

Committee personnel and the areas in which they will serve will be announced shortly, Mr. Schuchert said.

Progress Report On Heat Pump Research

A Supplement to the Article Published in March, 1948, EEI Bulletin

PREPARED BY THE JOINT AIEC-EEI HEAT PUMP COMMITTEE

IN THE March, 1948, issue of the EEI BULLETIN the Joint AEIC-EEI Heat Pump Committee reported on several research projects concerning the heat pump. These projects were being conducted by universities, research agencies or utility companies throughout the United States.

Much of the work, on which the initial article reported, has been completed. In some instances the overall project is being continued, with specific phases of the work having been completed.

This article has been prepared so that those interested in heat pump research programs may know what progress has been attained during the past year. The article concerns only those projects on which authoritative information has been submitted to the Joint AEIC-EEI Heat Pump Committee.

In addition to the investigations regarding the use of the heat pump as a year round air-conditioning unit, the committee has recently initiated similar investigation on the use of heat pump water heaters. Several manufacturers have shown interest in this device and are planning to install pilot models for field testing in the near future.

American Gas & Electric Company

This project sponsored by the subsidiary companies of the American Gas & Electric Company is located at the Tidd Plant of the Ohio Power Company in Brilliant, Ohio.

Three types of heat pickup units were tested through the period April, 1947, to June, 1948. These were: (1) Tapered monotube piles; (2) Horizontal surface tube bundle; and (3) Vertical concentric pipes.

Investigation of earth as a heat source was begun in December, 1947. Tests were run on all three heat absorbers with circulating water above 32 F. Additional tests were run on types (2) and (3) using a solution of anti-freeze and water at temperatures below freezing.

Surface (1) consisted of two 40-ft and one 50-ft tapered monotube piles driven vertically in the ground. Surface area was 116.8 sq ft for the 40-ft tubes and 149.7 sq ft for the 50-ft tube.

Surface (2) consists of an extended surface tube bundle 30 ft long and approximately 3 ft in diameter, buried horizontally with the center line of the bundle 5 ft from the surface. The tube bundle contains 200 ft of 1½-in. OD standard steel pipe connected in series by U-bends and held together with longitudinal and radial steel fins. Primary surface area is 106 sq ft; secondary surface area (fins), 412 sq ft.

Surface (3)—vertical concentric pipes—consists of five 20 ft lengths of 2-in. IPS wrought iron pipe. A one-in. IPS wrought iron pipe was inserted in each of the larger pipes to within about 3 in. of the bottom, after the larger pipes were driven into the ground.

Tests indicated that an extended surface, such as the radial and longitudinal plates of surface (2), does not improve the heat transfer between the refrigerant and the ground, and consequently cannot be justified.

Of the three surfaces considered, it is believed that surface (3)—vertical concentric pipes—offers the best possibilities as a practical surface from the viewpoint of heat transfer, installation, and initial cost.

The ground in which the heat transfer surfaces were located consisted of pebbles, gravel and sand with sufficient clay to act as a binder. There were numerous medium size rocks distributed throughout the area.

Earth as a Heat Sink

The earth was used as a heat sink from May, 1947, to September, 1947. These tests simulated a heat pump system operating on the cooling cycle which is rejecting its condenser heat to the earth. The tests were made in order to determine heat transfer rates between a given embedded surface and the earth. The tapered monotube piles—Surface (1)—were the only surface used in testing the earth as a heat sink.

The report indicated that the overall coefficient of heat transfer decreases with time and increases with increasing water temperature.

The Connecticut Light & Power Company —University of Connecticut

The project initiated in November, 1946, at the University of Connecticut and directed by Professor C. H. Coogan, Jr., has been completed. A report was published in August, 1948, titled "The Residential Heat Pump in New England."

The ground coil in this experimental installation consisted of several different independent circuits each approximately 150 ft long on the horizontal plane in the earth. The coils were placed at three levels—4, 6 and 8 ft below the surface, and were constructed of type K copper tubing.

Some of the important conclusions reached by Professor Coogan after analysis of results from this project are listed below:

1. The ground coil appears feasible and most favorable for use as a heat source for residential heating in New England.
2. About 6 ft below the surface seems to be a reasonable depth for the the ground coil in southern New England.
3. The local physical properties of the soil will need to be known before an ideal design can be made.
4. A moist soil is superior to a dry one for two reasons:
   (a) due to the higher thermal conductivity of moist soils and
   (b) due to the greater heat of fusion for the wetter soils. This latter factor will be most useful during periods of intermittent operation.
5. Moisture migration appears to take place in the soil due to the temperature gradient in the direction of the buried tube. Such migration, if sustained, will be helpful

in that the added moisture will improve other factors.

6. Results indicated that the heat absorption per foot of tube is not increased greatly by using larger diameter tubing.

Copies of this report may be obtained from the Edison Electric Institute at 50 cents per copy.

Kansas C. R. E. A.—U. S. Dept. of Agriculture

Investigation on the use of earth as possible heat source for the heat pump was started at Kansas State College in 1947. Insufficient data is available at the present time to present a comprehensive discussion of the test results.

Two 100 ft lengths of 1⅛-in. OD copper pipe are buried in different trenches at a depth of 6 ft. One pipe is buried in a trench having a U-shaped plan view such that the legs of the U are 10 ft apart. The other pipe is buried in a single trench 50 ft long. The pipe extends up one side of the trench and doubles back in the shape of a hair pin with the return leg spaced at 2 ft and parallel to the outgoing leg. Either pipe may be connected with either of two water tanks. One tank is equipped to circulate water or brine cooled by a standard Freon compressor. Cold water was circulated during the past winter to simulate the heating cycle of the heat pump. At mid-length on both pipes, thermocouples are placed in a vertical plane perpendicular to the pipes. The thermocouples are so spaced as to give a picture of the temperature gradient in the plant extending from the ground surface to a depth of 11 ft and extending out horizontally from the pipe for a distance of 5 ft. In all, over 260 thermocouples are employed. Most of the thermocouples are spaced one ft apart. The spacing is reduced to 3 in. close to the pipe since tests have shown a very steep temperature gradient exists within the first 6 in. out from the pipe.

The temperature gradient is being studied in relationship to the physical properties of the soil with special attention being given to the moisture content. The relationship between the temperature gradient and the total amount of heat given up by the soil or absorbed by the soil is being carefully observed. The rate of temperature recovery is noted when water or brine circulation is stopped.

In the fall of 1948 a cooperative agreement was entered into with the U. S. Department of Agriculture. The agreement provided for a full-time research engineer and certain funds to aid in work already under way and to initiate further investigations relating to the heat pump. As a result, an additional project has been undertaken aimed at determining the basic factors influencing the transfer of heat in soils. The ultimate goal of the project is to render it possible by making a few relatively simple tests on the physical properties of any soil to accurately predict its behavior when used as a heat source or heat sink for the heat pump. It is hoped that by correlating the information gained from this investigation with knowledge acquired through field studies of heat transfer in the soil, a sound basis may be established for the design and operation of heat exchangers in the earth.

The Kansas Power & Light Company—Kansas C.R.E.A.

The Kansas Power & Light Company has installed a heat pump in a substation building near Manhattan, Kansas. The primary objective of the installation is to secure design data pertaining to earth heat exchangers for the purpose of using the earth as a source of heat on the heating cycle and for dissipation of heat during the cooling cycle.

The unit is one assembled for this particular test, consisting of a 2-hp motor and standard refrigeration compressor, together with three different types of ground coils through which Freon 12 is circulated. One of these coils consists of 52 ft of 1⅛-in. OD copper pipe placed horizontally in a 25-ft trench at a depth of 5 ft. The coil is U-shaped with the two legs spaced 12 in. apart. The other coils are a vertical type extending downward a distance of 7 ft from the bottom of a trench 3½ ft deep and spaced at 10 ft intervals. The unit as installed was too small for supplying the entire heat requirements of the substation in order that it would be operating a maximum amount of time and that the ground coil would be operated at the most severe conditions possible.

Two additional ground coils were installed during the first part of April, 1949, based upon the results secured during the past winter season. One of the new coils consists of four tubes each 10 ft long having fins extending outward from the tube a distance of 6 in.; extending downward into the earth to a depth of 13½ ft, and spaced at 15-ft intervals. Another coil consists of four tubes each 20 ft long without fins, extending downward to a depth of 23½ ft and spaced at 15-ft intervals. These coils are being tested on the cooling cycle along with the three coils used during the winter. A 3-hp variable speed motor has replaced the original motor so that the entire cooling and heating requirements may be handled by the heat pump.

In addition to hourly operating data which was recorded throughout the winter months, special tests were made to determine the relative effectiveness of the different types of ground coils. These tests indicated the importance of placing earth heat exchangers as deep as is practical. The tests also indicated the feasibility of using Freon 12 in vertical ground coils without difficulty of oil separation. A standard commercial oil separator was installed at the compressor.

Philadelphia Electric Company—Chrysler Airtemp

The test period for the joint project sponsored by the Philadelphia Electric Company and the Chrysler Corporation, Airtemp Division, was initiated with the installation of two residential heat pump units in the Philadelphia area.

The units are specially-engineered and factory built, package units, electrically-driven heat pumps of 5-hp size utilizing earth as a heat source.

One unit is installed in a residence in Whitemarsh of 27,000 cu ft volume, including basement. The calculated heating requirements for this installation is 90,000 Btu per hr, and the cooling requirements 40,000 Btu per hr.

The ground coil for this installation consists of three loops of 1½ in. wrought iron pipe buried in trenches 5 ft below grade. Amount of pipe in each coil is as follows: 764 ft of pipe in 382 ft of trench; 652 ft of pipe—326-ft trench; 744 ft of pipe—372-ft trench.

The test period will cover the use of single loops and also all combinations to compare the amount of heat absorbed.

Circulation medium in both installations consists of water and ethylene glycol, the glycol representing 18 per cent by volume. There are 280 gal of fluid in this system flowing at a rate of 15.5 gpm.

The second unit is installed in a residence in Lansdowne. The volume of the conditioned space is 23,400 cu ft including basement.

The calculated heat requirement is 75,000 Btu per hr and the cooling requirement 34,000 Btu per hr.

Ground coil consists of three loops of 1½-in. wrought iron pipe, as in the first installation; however, the loops are of shorter length. Coil and trench lengths are as follows: 434 ft of pipe—217-ft trench; 416 ft of pipe—208-ft trench; 530 ft of pipe—265-ft trench.

There are 210 gal of circulating fluid in this system flowing at 13.0 gpm.

The earth temperature at the start of test period, October 5, 1948, was 66 F at Whitemarsh and 64 F at Lansdowne. Minimum earth temperature to April 6, 1949, was 44 F at Whitemarsh and 46 F at Lansdowne.

Thermal conductivity is being measured at both locations with an 8-in. hollow copper ball having resistance heating units uniformly distributed throughout the interior.

Detailed analysis of tests results will be made on completion of testing period.

Southeastern Electric Exchange—Southern Research Institute

In order to observe the operation of an installed heat pump unit operating under normal conditions, a 7½-hp package unit heat pump, using air as a heat source, was installed in Laboratory No. 5 in March, 1948. The unit conditioned the first floor office space.

The calculated heat load was 67,825 Btu per hour and calculated cooling load, 60,221 Btu per hour. Volume of the conditioned space is about 24,700 cu ft.

Proposed problems to be considered by the Institute during 1949 are concerned mainly with residential use of the heat pump. The items for probable investigation are as follows:

1. Studying and evaluating various heat sources for the Southeastern Region.
   a. Air coil defrost
   b. More efficient ground coil layout
   c. Combination heat sources
      1. Solar heat
      2. Storage
      3. Water or ground coils with air
2. Determining the acceptable means of securing comfort conditions.
   a. Grill location
   b. Duct design
   c. Permissible air velocities
3. Cooperation in testing a manufacturer's pilot model residential heat pump unit.
4. Securing more information on heat pumps in the Southeast.
   a. Installation costs
   b. Operating cost
   c. Unit performance
   d. Power requirements

During 1948 the Southern Research Institute published three reports: (1) "Tests on Heat Transfer of Buried Vertical Tanks," (2) "Economic Analysis of Earth and Air Heat Sources," and (3) "Requirements for Residential Comfort and Their Application to Heat Pump Systems." At the time of this article there have been three reports published in 1949: (1) "Comparative Performance Tests on Clay and Sand Fills Around Buried Pipes," (2) "One Year's Operational Data on an Air to Air Heat Pump," and (3) "Economic Analysis of Earth and Air Heat Sources, Part II." Prior to these reports there were 14 additional reports on various subjects pertaining to heat pump installation or operation.

Several investigators are considering the use of some type of fill around an earth coil in order to increase the heat transfer rate. Conclusions of the report entitled "Comparative Performance Tests on Clay and Sand Fills Around Buried Pipes" will be of interest to this group.

The following data appear in the Summary of this report.

A series of tests were run on two 88-ft long, 1⅛-in. OD copper tube coils to evaluate the effect of a sand fill. One coil was buried with about 6 in. of sand around it and the other in an ordinary clay fill.

It appears that the choice between clay and sand fill depends on the most critical function of the coil. Sand is superior in picking up heat while clay is superior in dissipating heat.

The conclusions are that sand appears to aid in the movement of moisture to and from the buried pipe. However, it should be remembered that these results are not necessarily general. They indicate only results using one size pipe in one soil in this particular locality, Birmingham.

Texas Electric Service Company

The project initiated in 1947 concerning the use of earth as a heat source is being continued by the Texas A & M Research Foundation at College Station.

Tests of the properties of typical soils common in Texas and elsewhere, for determining thermal conductivity, heat capacity, diffusivity and effect of moisture migration caused by thermal gradients have continued, using Patten-type and later the Shannon-and-Wells-type laboratory apparatus. Correlation of results by the two methods, and with the values obtained by guarded-hot-plate method independently in another laboratory, is in progress.

Values of pH and electrical resistivity of all soil samples were measured, as a guide in determining extent and kind of protection against corrosion, required for buried coils. There was no correlation between these properties, which are dependent on chemical composition, and the physical properties affecting thermal performance of the soils studied.

A preliminary investigation with thermocouples and moisture apparatus, of soil temperatures and water contents in the vicinity of a buried cold pipe has been concluded. Another study is being completed, on calculation of heat capacity of soil with a stipulated moisture content, from the known heat capacities of dry soil and of water.

Work of the project is being expanded for the current year, to cover field investigation of temperature and moisture in soil placed at a known condition around hot and cold buried coils. This will utilize a refrigeration unit and electric immersion heaters to control temperature of the circulated heat-exchange fluid, instruments for continuously measuring soil temperatures and heat quantities, and a soil-sampling method for laboratory determination of moisture content at various points throughout the tests.

A report titled "Some Aspects of the Soil Problem in Connection with Heat Pump Buried Coil Design" was presented before the Midwest Power Conference at Chicago in April, 1949, by D. M. Vestal, Jr., project supervisor, Reverse Cycle Heating Project, Texas A & M Research Foundation.

Union Electric Company of Missouri

The Union Electric Company of Missouri is continuing the project started in November, 1946. The objective of the program is to determine the practicability of heating a residence by means of a heat pump and to investigate:

a. The use of ground coils and the extent to which heat can be extracted from the earth for residential heating.

b. The use of an outdoor heat transfer unit to extract heat from the air for residential heating.
c. A determination of the value of a combination of heat sources using both air and ground.
d. To determine the extent to which the earth can be used as a heat sink for condensing purposes for summer air condition.

In order to more thoroughly test the capability of the ground coils, there has now been installed, in addition to the 5-hp package unit which was previously used, a refrigerating compressor operated by a two-speed motor, together with heat exchangers and other auxiliary equipment. Depending on the motor speed, this unit is capable of operating at 5 ton or 10 ton refrigerating capacity. The installation is so arranged that either the package unit or the new larger equipment can be operated.

Steps are now being taken to determine soil characteristics and soil moisture content under varying operating conditions and to relate these to the operating data obtained to date. It is hoped that a more detailed report can be made available in the near future.

University of Washington

The project, sponsored by Bonneville Power Administration and Engineering Experimental Station, University of Washington, concerning the study of the use of the heat pump for residential heating, was started in October, 1946, and will continue.

This project is divided into four phases:

1. A study of a heat pump installation.
2. A study of the temperatures of the ground and available bodies of water, at various depths, throughout the year.
3. A study of heat absorbed by buried pipes carrying heat absorbing fluid.
4. A study of the heat conductivity of soils.

Residential Heat Pump Installation

Operating data for a residential installation, using a package unit, have been recorded over a complete heating and cooling period. A report on this phase will be published in a national heating magazine in the near future.

In addition to the continuation of the tests on the above residences, arrangements are in progress to select several other residences for similar studies. These homes will be selected with reference to the type of heating source, that is, some using open well, others closed well, ground grid, lake water, etc.

Ground and Water Temperatures

The temperatures at varying depths are recorded weekly for two stations to a depth of 10 ft below the surface and also for one station to a depth of 50 ft. Continuous temperatures are recorded in a 50-ft well near the Weather Tower located on the University Campus. This project is in cooperation with the Climatology Department. Records for a complete year will be available on all stations by the end of the present school year.

Heat Absorption by Ground Grids

The major effort has been expended on the third phase of the project. Considerable data were obtained by circulating Freon 12 through about 180 ft of ½-in. copper tubing buried 2 ft below the surface. A calorimeter test was also made to determine the rate of flow of the refrigerant and thus establish the rate of heat flow.

An automatic expansion valve was used in these tests. Because of the heat of vaporization, the tubing carrying wet gas absorbed two or three times the heat absorbed by that portion carrying superheated gas. In practical installations, the system should be so designed that the maximum possible tubing will be carrying wet gas.

This test period concerned the use of ground coil buried at a depth of 2 ft. During the past summer and fall the study was continued using water in a ¾-in. copper tube. The results were in line with the previous test except that they were lower due to the lower moisture content of the soil.

At present a new series of tubes are being installed, a portion at a depth of 6 ft and the remainder at a depth of 4 ft. Basing the design upon the experience gained at a depth of 2 ft, efforts will be directed toward a study of single as well as parallel tubes at varying distances from each other. Parallel tubes at the 4- and 6-ft depths operating at the same time will also be studied. Sufficient thermocouples to obtain isothermal patterns about the tubes are being installed in order to determine the extent of the heat flow from various directions toward the tubing.

Soil Conductivity

Although the study concerning conductivity of the soil is not completed, a brief summary of some of the data indicates the following trends:

1. The values of thermal conductivity of the soils thus far tested vary from about 0.2 to 1.2 Btu/hr/ft/sq ft/deg F depending largely upon the moisture content and density of the soil.
2. The mean temperature difference between the hot and cold sides has very little effect on the soil thermal conductivity. In the range of freezing temperature and above, a nominal increase of about 0.03 for every 10-deg rise in the mean temperature seems evident.
3. The density of the soil has a very marked effect on its thermal conductivity. An increase of 10 lb per cu ft may increase the value of conductivity as much as 0.2 and the effect is almost linear. However, moisture is also a factor, and for dry soil the increase is somewhat less.
4. The conductivity increases almost linearly over the range of 5 to 20 per cent moisture content, based on dry weight. Below and above these limits the change of thermal conductivity is much less per unit of moisture content change.

The University is also starting to measure the thermal conductivity of undisturbed soil and plans to seek some relation to electric conductivity.

Utilities Research Commission—Commonwealth Edison Co. and Associated Companies

The investigation by the Utilities Research Commission has been almost entirely to obtain data on adequate heat sources for installations in the Chicago area and to determine how to apply the information to the various conditions that exist in this area.

Equipment was installed to determine the effectiveness of three different arrangements for extracting heat from the earth. No attempt was made to heat a building or to determine the overall performance of the test equipment. After measuring the amount of heat extracted, it was discarded through water-cooled condensers.

Two types of heat collectors were used in this investigation. One type of collector, designated the "Buried-Pipe System," consists of copper pipes buried horizontally in the earth. A refrigerant such as Freon 12 or a suitable solution such as water and antifreeze is circu-

lated through the pipes. If the refrigerant is used, the pipes serve as the evaporator; if solution is used, the buried pipes serve as a heat exchanger between the earth and the solution, which is also circulated through a conventional evaporator of the refrigerating equipment.

The other type of heat collector, designated the "Well System," has a loop of pipe submerged in a well. A liquid, which is non-freezing at operating temperatures, is circulated through the pipe and through the evaporator where it is refrigerated. The remainder of the equipment is the same as for the buried pipe system.

Each buried pipe system consists of 155 ft of 1⅝-in. OD hard copper tubing arranged in a horizontal loop approximately 70 ft long and 10 ft wide. One loop is buried 2 ft and the other 6 ft below the surface. (Each buried pipe system was connected to its own refrigerating system and measuring instruments.) There is a third loop located 6 ft below the surface in the same trench as the loop at the 2-ft level; this loop will be incorporated in future testing.

The well system consisted of a 5-in. well, 214 ft deep, cased with 5-in. steel pipe to 51 ft below the ground surface. The remainder of the well was drilled in solid rock. A U-tube of 1¼-in. galvanized steel pipe extended to the bottom of the well and was connected to an independent set of refrigerating and measuring equipment.

Standard open-type, two-cylinder compressors of 27 cu in. displacement, belt driven by 3-hp motors, were connected to the buried pipe systems. A semi-hermetic, two-cylinder compressor of 41.5 cu in. displacement was connected to the well-system. The compressors and other equipment were intentionally selected oversize so as not to limit the heat absorbed by the heat collectors.

The three systems were operated intermittently during each day, simulating a heating cycle, from October 1, 1947, to May 31, 1948, whenever the mean air temperature was less than 65 F.

The test results to date indicate that the buried pipe system can be designed so that the earth can be used as an adequate heat source in the Chicago area. The well system, however, did not supply as much heat as had been expected, and for conditions similar to the test location, can be considered inadequate.

The soil characteristics problem has not been solved. A large amount of data is yet to be obtained for full consideration of the effects of soil characteristics.

Wisconsin Electric Power Company

The project sponsored by the Wisconsin Electric Power Company was set up in such a manner as to simulate actual operation during the heating season of 1947-1948.

For this test period twenty units of 3-in. iron pipe in 10-ft sections were used. These units were buried vertically in an area 20 by 72 ft. The twenty units were connected with ¾-in. pipe forming a rectangular circuit. The circuit was the heat absorber for a 3-hp package heat pump unit.

The earth consisted of yellow clay to a depth of 14 ft and blue clay below this level. The water table was 78 ft below grade.

Thermocouples recorded ground temperatures from 1 ft to 22 ft below grade. The following table shows the highest and lowest recorded temperatures at the various depths below grade:

Depth Below Surface	*Lowest Temperature*	*Highest Temperature*
2 Ft	33 F in Mar.	67 F in Aug.
7 Ft	39 F in Apr.	58 F in Sept.
12 Ft	43 F in May	54 F in Oct.
17 Ft	46 F in June	52 F in Nov.
22 Ft	47 F in July	51 F in Jan.

Report on this project indicated that it would be advisable to investigate the use of coils at lower depths since the highest temperatures were found at these levels during the months when most heat would be needed for heating purposes.

It has been suggested that this method be improved by using 20-ft sections of 2-in. pipe. The additional length would extend the absorbing surface to the level where the smallest differential in ground temperature occurs. The decreased diameter would make it possible to install the pipes with a power digger thus avoiding handling and backfilling of earth.

Electric Utilities—General Electric Company

The General Electric Company, in cooperation with a group of utility companies, is engaged in a field test program of packaged heat pump units. Utilities concerned, which have installed these units and are obtaining operating data are the Central Power and Light Co., Corpus Christi, Tex.; Alabama Power Company, Birmingham, Ala.; Potomac Edison Gas Company, Camden, N. J.; The Ohio Power Company, Canton, Ohio; Central Hudson Gas & Electric Corporation, Poughkeepsie, N. Y.; and the Narragansett Electric Company, Providence, R. I.

The types of structures in which installations are made include residences, offices, a store and a clinic.

These pilot models are completely automatic and use air as a primary heat source with some installations using water or a ground coil as a supplementary source. Two 3-hp compressors are engaged in each unit, some being operated on three-phase power supply and others on single phase.

Each installation is completely instrumented to obtain detailed and accurate conditions of performance. All temperature, pressure, electrical and other instruments are mounted on a panel board. An automatic camera records all readings periodically and also upon signal from a change of operation of the heat pump, thus data obtained from the film provide a complete operating record and permit detailed analyses of performance under all conditions of operation.

American Gas & Electric Company—York Corporation

The American Gas & Electric Company and the York Corporation are jointly sponsoring a program in which five pilot model package heat pump units will be studied under normal residential operation. Installations are located in the following cities: Kingsport, Tenn.; Abingdon, Va.; Roanoke, Va.; Coshocton, Ohio; and South Bend, Ind. More detailed information concerning these installations may be found in the May, 1949, issue of *Heating & Ventilating*.

The Joint AEIC-EEI Heat Pump Committee realizes that there are probably other research programs in progress concerning application of the heat pump; however, comprehensive information regarding these other programs or projects has not come to the attention of the committee. If detailed information is submitted to the committee it will be included in a future article.

Chairman of the committee is E. R. Ambrose, American Gas & Electric Service Corporation, 30 Church Street, New York 8, N. Y.

More detailed information on the projects included in this article may be obtained by contacting A. T. Boggs, Edison Electric Institute.

PERSONALS

EDGAR H. DIXON has been made president of Middle South Utilities, Inc., recently formed following the reorganization of the Electric Power & Light Corp. Mr. Dixon has been president of Electric Power & Light Corp. since 1944.

Prior to his election as EP&L president, Mr. Dixon had served as secretary and treasurer and then as executive vice president of the company.

Middle South Utilities will acquire the common stock of the four companies comprising the closely integrated ALMNO system, Arkansas Power & Light, Louisiana Power & Light, Mississippi Power & Light, and New Orleans Public Service.

Announcement has been made of the appointment of MILTON L. KAPP as executive vice president and of C. A. HUMMEL as vice president of the Interstate Power Co., Dubuque, Iowa. Mr. Kapp succeeds F. D. DANIELSON, who resigned to become associated with the Public Service Co. of Indiana as a vice president.

Mr. Kapp obtained his early experience with the Chandler (Okla.) Electric Co. and the Oklahoma Natural Gas Co. He became associated with the Michigan Public Service Co. at Traverse City in 1936 as operating superintendent, and was made vice president in 1938. The following year he joined Interstate Power as assistant to the president and in 1945 became a vice president.

Mr. Hummel rejoined Interstate as chief engineer in 1939. Previous to that time he had worked in the general office drafting department and as a construction engineer with Interstate in 1926, later transferring to Central States Power & Light Co. He served as field engineer, southwest district engineer in Tulsa, and as chief engineer of the company before being transferred to St. Louis, where he remained until rejoining Interstate.

Announcement was made at the same time of the promotion of E. P. NANEY to chief electrical engineer and L. P. HARLAN to chief production engineer.

Announcement has been made by the Pennsylvania Power & Light Co. of Allentown, of the appointment of three vice presidents.

G. THEODORE STORB, formerly PP&L division head, has been made vice president of the company's Lancaster division; J. C. KNOWLES, vice president of the newly formed Lehigh division in the merging of two of the utility's major commercial divisions; and JAMES M. HUEBNER has been appointed vice president in charge of commercial operations.

Mr. Storb joined predecessor companies of PP&L in 1923. In 1925 he became statistician for these predecessor companies, the Edison Electric Co. and the Lancaster Gas Light & Fuel Co. and three years later was made chief engineer. Upon merger of the two organizations with PP&L in 1930, he became distribution engineer, Lancaster division, in 1939 division commercial manager and in 1944 division manager at Allentown.

Mr. Knowles joined PP&L in 1924 and, leaving in 1928 to become electrical engineer for Monongahela West Penn Public Service, he rejoined PP&L in 1932. He has been identified with the Williamsport district and the Susquehanna and Bethlehem divisions. After service in World War I, he spent several years with eastern utilities prior to joining PP&L.

Mr. Huebner was a division vice president at Lancaster at the time of his new assignment. He joined PP&L in 1924 in the line department and served as a district manager and later division manager at Bethlehem. Earlier in his career he was associated with the Carnegie Institute of Research, Washington, D. C., and the Phoenix Utility Co.

L. W. HEATH, formerly vice president in charge of commercial operations, has been assigned special executive duties.

Three executives of New Orleans Public Service Inc. have been elected vice presidents. Those promoted include STREUBY L. DRUMM, general sales manager; WALTER J. AMOSS, director of advertising and GEORGE S. DINWIDDIE, economist.

Mr. Drumm has been general manager since 1940. He became identified with the New Orleans utility in 1925 as a commercial salesman. Subsequently he served as assistant rate engineer, residential sales manager, industrial and commercial sales manager.

Mr. Amoss has been associated with the company since 1931, when he was employed as an engineer in the industrial and commercial service department. Subsequently he was appointed general sales manager and then assistant to the vice president in charge of operations. Later he was made director of advertising.

Mr. Dinwiddie was first employed by the company in 1936 as a tax and research clerk. Later he became budget director and executive office assistant and more recently head of the budget and statistical department.

Announcement has been made by the Texas Electric Service Co., Fort Worth, of the election of two new vice presidents, BEEMAN FISHER, assistant to the president, and PERRY DAVIS, manager of the Wichita Falls district.

Both Mr. Fisher and Mr. Davis have had many years' experience in the electrical industry in Texas and have been associated with Texas Electric Service for more than 10 years.

WRIGHT CANFIELD, formerly assistant to the president of the Public Service Co. of Oklahoma, Tulsa, has been elected a vice president.

Starting in the general office engineering department in 1930, Mr. Canfield later was assigned to the Weleetka power station and, after returning again to Tulsa, was placed in charge of construction for the expansion of service facilities at the Bartlesville power station and in the Nowata district.

In 1944 he was made head of the company's research department and a year later he was appointed assistant to the president.

WARREN L. PORTER has been appointed a vice president of Kansas City Power & Light Co., filling the vacancy caused by the retirement of H. H. Kuhn.

Mr. Porter has been the head of the rate and appraisal department of The United Light and Railways Service Co., service organization of the Power & Light Company holding companies. Mr. Porter was graduated from Iowa State College in civil engineering in 1918 and served as a 2nd lieutenant in the engineer corps in World War I. Following his army service, he joined the utility holding company in 1919. He became rate and appraisal engineer of the service group in 1931.

Electric and gas transmission and distribution engineering work of Consolidated Edison Company of New York, Inc., has been reorganized under the direction of J. ELIOT MCCORMACK, formerly staff engineer in the electrical engineering department. The new group will report to Charles W. Franklin, electrical engineer.

Mr. McCormack will head the new Transmission and Distribution Bureau as chief distribution engineer. All of the engineering associated with transmission and distribution will be consolidated under the new bureau. Previously, this work was done by several different groups. Assisting Mr. McCormack will be THOMAS C. DUNCAN, THOMAS MAXWELL, SEWARD A. WARNER, distribution engineers, and CLADD H. CHASE, superintendent.

Mr. McCormack is the new chairman of the Transmission and Distribution Committee of the EEI, recently appointed for the current year.

ALLEN N. CARTWRIGHT has retired as vice president of the West Penn Power Co. after completing nearly 46 years of service.

Mr. Cartwright is one of the outstanding figures in the technical end of the electric utility business. Starting with West Penn at Connellsville in 1903, Mr. Cartwright became foreman on construction and operation of substations the following year and three years later was placed in charge of all electrical construction of substations and power stations. In 1911 he was made superintendent of operation of power stations and substations. This position he held for 18 years. His headquarters were transferred in 1915 from Connellsville to Pittsburgh. Appointment as general superintendent of the power division preceded by 10 months his election to the vice presidency in 1930. In this capacity, Mr. Cartwright was responsible for all construction, operation, and maintenance of the physical property used in the operation of the company's business.

E. D. MILLER, West Penn Power Co. district manager at Greensburg, has been named manager of the Company's Eastern Division, with headquarters at Greensburg. Mr. Miller replaces L. F. Blassingham, who has resigned.

Announcement was made of the following changes in district managerships.

M. L. BOUCH is the new Greensburg district manager, moving up from his present post as Latrobe-Ligonier District manager. Replacing Mr. Bouch at Latrobe is R. C. MCMAHON, presently district manager for West Penn at Springdale.

The company will combine Springdale district with New Kensington for operating purposes under K. E. RUPERT, New Kensington manager.

The new Eastern Division manager has been with West Penn for 27 years. He started as assistant district superintendent at Greensburg in October, 1921, and was made district manager in December, 1923. He is an Electrical Engineering graduate of Penn State.

Before joining West Penn's employ, Mr. Miller was affiliated with the Seamless Tube Company, McKeesport Tinplate Company, and Duquesne Light.

Mr. Bouch, the new district manager at Greensburg, joined West Penn in March, 1924. He worked as solicitor, district chief clerk, division chief clerk, and assistant superintendent in various districts of the Company's Northern Division, which has headquarters at Kittanning.

In April, 1931, he was named district manager at Springdale. In 1934 he was transferred in the same capacity to Vandergrift, and in 1935 moved to Latrobe.

Mr. McMahon has been with West Penn since 1926. He has held various positions in the Company's Northern Division, including district chief clerk, division solicitor, division chief clerk, and assistant district manager, being named Springdale manager in 1939.

W. F. FICKLEN, vice president of the Appalachian Electric Power Co., with headquarters in Charleston, W. Va., has retired. Mr. Ficklen will continue to be available to the company in a consulting capacity. Mr. Ficklen has been associated with Appalachian for more than 30 years. He was made division manager 22 years ago and vice president in 1943. He has supervised and directed expansion of the company's facilities in the Charleston area. Mr. Ficklen began his career in the electric utility business in Vermont and went South in 1912.

HOWARD E. ORTON, manager of the Endicott-Owego District of the New York State Electric & Gas Corp., has been appointed to succeed William H. McElwain as manager of the Binghamton Division.

Mr. McElwain has resigned to accept an executive position with the Metropolitan Edison Company at Reading, Pa.

Also announced was the separation of the former Binghamton Division, the largest in the company's territory, into two divisions. Under the new plan, the Binghamton Division will incorporate the Triple Cities and Owego areas. The other, the Oneonta Division, will include the area now within the Oneonta District and in addition will embrace the Liberty District as it is now constituted. The separation is designed to provide improved service to the area.

ANDREW R. EWING, Oneonta District manager, has been made manager of the Oneonta Division. His headquarters will continue at Oneonta.

HAROLD P. ALLEN will continue as manager of the Liberty District.

Mr. Orton entered the utility field as a securities salesman for the Adirondack Power & Light Co., now the New York Power & Light Co., at Oneida in 1924.

He joined the New York State Electric & Gas two years later and for the next 13 years worked on special assignments. In 1939, he became commercial office manager of the Binghamton District and in 1941 he was appointed manager of the Endicott District, later enlarged to include the Owego area.

Mr. Ewing was graduated from Rider College where he completed business and secretarial courses. He later was a special student in finance and foreign exchange in the Graduate School of Finance, New York University.

Mr. Ewing entered the utility field in 1924 at Asbury Park for the Eastern New Jersey Power Co., taking charge of credit and collection work. After two years he entered merchandising for a year with the A. E. Fitkin Co., traveling the South extensively.

He became associated with New York State Electric & Gas in 1927 as supervisor of merchandising in the Oneonta, Walton and Liberty areas. He later took charge of all new business in the Norwich and Oneonta Districts and in 1932 became district manager at Walton. He was transferred to Liberty as manager in 1936 and was appointed Oneonta District manager in 1945.

Training Programs Designed To Meet Nine Objectives

(*Continued from page* 303)

of a 132,000-volt underground cable. Inspection trips of company property are also planned from time to time.

(b) *Meral Club.* The girls in the company have a club which meets each month from October to May to conduct programs of interest to their members. One of the meetings held each year is of particular interest in that girls who have worked for the Company are invited back as alumnae to attend a special meeting. A mother and daughter banquet in May winds up the year's program.

(c) *Veterans' Association.* All employees of the Company who have had 20 or more years of service are eligible to join this club. Four meetings a year are held to initiate new members and to give recognition for continuous, reliable service. Employees who have completed 40 years of service are initiated into a higher degree called "double veteran" at which time the Company presents a beautiful wrist watch in recognition of service.

The Company's Stockholder Report is mailed to each employee's home. This report has been prepared in graphic style to make the information easily understood by employees.

A Library, which includes a reading room, a reference section with magazines and textbooks, is available to all employees.

Providing Training Aids and Services

The Employee Training Division assists in the work of job evaluation and in training committees for this activity. Assistance is also given in the analysis of employee ratings and furnishes employee counseling. That part of a supplemental pension plan which requires contacts with employees is administered by the Employee Training Division. Employees who have training jobs to do for people outside of the company make use of the projection equipment and other aids available for such work.

Training is a help in solving operating problems. If a problem is looked at as anything that interferes with smooth operation, then training has a part to play. Training programs, therefore, are designed to help build a more effective work force, which, in tu reduces interference with smooth ope tion.

CONVENTIONS AND MEETINGS

SEPTEMBER

11-14 Rocky Mountain Electrical League, Fall Convention, Stanley Hotel, Estes Park, Colo.
15 Board of Directors, EEI, Cleveland, Ohio.
16-17 The Maryland Utilities Association, Fall Conference, Cavalier Hotel, Virginia Beach, Va.
16-17 Public Utilities Association of the Virginias, Greenbrier Hotel, White Sulphur Springs, W. Va.
19-23 Illuminating Engineering Society, National Technical Conference, French Lick Springs Hotel, French Lick Springs, Ind.
20-21 Pennsylvania Electric Association, Annual Meeting, Benjamin Franklin Hotel, Philadelphia, Pa.
22-23 Southeastern Electric Exchange, Accounting Conference, Henry Grady Hotel, Atlanta, Ga.
22-23 Accident Prevention Committee, EEI, Robert Treat Hotel, Newark, N. J.
22-23 Industrial Power and Heating Section, EEI, New York, N. Y.
23-26 American Institute of Electrical Engineers, Pacific General Meeting, Fairmont Hotel, San Francisco, Calif.
25-28 Controllers' Institute of America, San Francisco, Calif.
28-30 American Society of Mechanical Engineers, Erie, Pa.
28-30 Indiana Electric Association, Annual Convention, French Lick Springs Hotel, French Lick Springs, Ind.
29 Industrial Relations Committee, EEI, AGA Headquarters, 420 Lexington Ave., New York, N. Y.
29-30 Rate Research Committee, EEI, 420 Lexington Ave., New York, N. Y.

OCTOBER

3-5 Meter and Service Committee, EEI, Leland Hotel, Springfield, Ill.
3-5 Electrical Equipment Committee, EEI, Van Curler Hotel, Schenectady, N. Y.
4-6 Canadian Electrical Manufacturers Association, General Brock Hotel, Niagara Falls, Ont., Can.
6-7 Pennsylvania Electric Association, Prime Movers Committee, Hotel Edison, Sunbury, Pa.
10-11 Iowa Utilities Association, Second Annual Management Conference, Fort Des Moines Hotel, Des Moines, Iowa.
11-14 American Standards Association, Annual Meeting, Waldorf-Astoria Hotel, New York, N. Y.
17-20 American Gas Association, Chicago, Ill.
17-21 American Institute of Electrical Engineers, Midwest General Meeting, Netherland Plaza Hotel, Cincinnati, Ohio.
20-21 Pennsylvania Electric Association, Transmission and Distribution Committee, Fort Ligonier Hotel, Ligonier, Pa.
24-26 American Trade Association Executives, Annual Meeting, Greenbrier Hotel, White Sulphur Springs, W. Va.
24-28 National Safety Council, Chicago, Ill.
25-27 Pacific Coast Electrical Association, Inc., Fall Conference, Hotel Californian, Fresno, Calif.
26-28 Industrial Relations Committee, EEI, Round Table Conference on Personnel Administration, Edgewater Beach Hotel, Chicago, Ill.
31-Nov. 1 Transmission and Distribution Committee, EEI, Lord Baltimore Hotel, Baltimore, Md.

NOVEMBER

2-4 American Society of Civil Engineers, Washington, D. C.
7-10 National Electrical Contractors Association, Rice Hotel, Houston, Texas.
14-18 National Electrical Manufacturers Association, Chalfonte-Haddon Hall, Atlantic City, N. J.
17-18 Pacific Coast Electrical Association, Inc., Annual Fall Conference, Fresno, Calif.

1950

JANUARY

30-Feb. 3 American Institute of Electrical Engineers, Winter General Meeting, New York, N. Y.

FEBRUARY

20-21 Transmission and Distribution Committee, EEI, Statler Hotel, Detroit, Mich.

MARCH

13-16 National Electrical Manufacturers Association, Edgewater Beach Hotel, Chicago, Ill.

MAY

1-4 38th Annual Meeting, Chamber of Commerce of the USA, Washington, D. C.
15-18 54th Annual Meeting, National Fire Protection Association, Haddon Hall, Atlantic City, N. J.
31-June 2 Pacific Coast Electrical Association, Inc., Reno, Nevada.

JUNE

6-8 Edison Electric Institute, Annual Meeting, Atlantic City, N. J.
12-16 National Electrical Wholesalers, Atlantic City, N. J.

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(Continued)

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